Ten Years of SARE

A DECADE OF PROGRAMS, PARTNERSHIPS AND PROGRESS IN SUSTAINABLE AGRICULTURE RESEARCH AND EDUCATION

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Valerie Berton
Editor/Project Manager
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PREFACE

Reaching a decade is a real milestone for SARE. Authorized in the 1985 Farm Bill, SARE began funding competitive grants in 1988 for agricultural research and education with a $3.9 million budget.

Ten years later, SARE administers grants that advance sustainable agriculture systems in partnership with producers, farm consultants, university researchers and administrators, state and federal government agency staff and representatives from nonprofit organizations.

Some of those partners lead SARE grant projects; others serve on regional technical committees and administrative councils to provide policy direction, identify information needs and, above all, select projects on a competitive basis.

To recognize the commitment of farmers, ranchers and agricultural educators, SARE has launched an innovative Producer Grant Program geared at on-farm research and a Professional Development Program targeted at Extension and the Natural Resources Conservation Service.

By 1997, Congress had increased funding for SARE to $11.3 million. That totals $80.6 million for sustainable agriculture programming over the last decade to fund close to 1,200 projects.

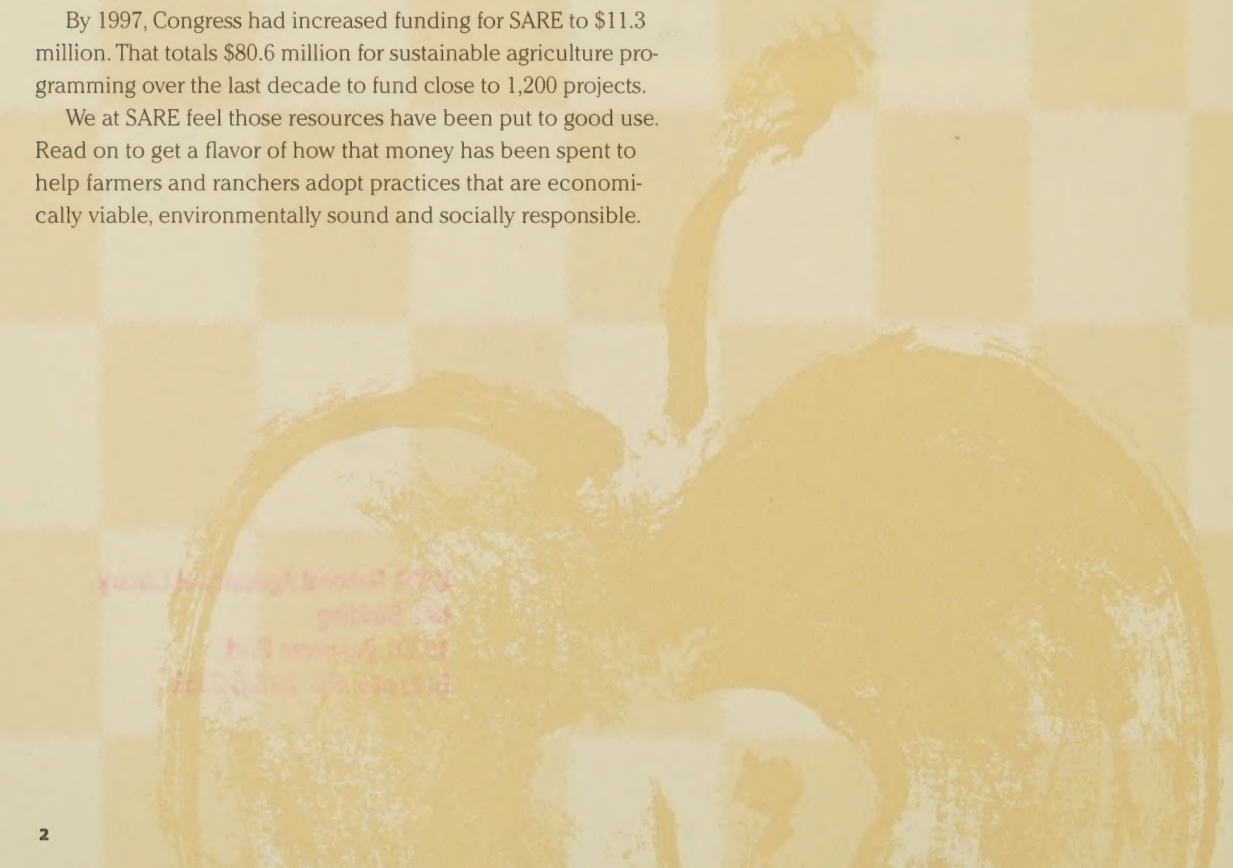
We at SARE feel those resources have been put to good use. Read on to get a flavor of how that money has been spent to help farmers and ranchers adopt practices that are economically viable, environmentally sound and socially responsible.

HOW THIS BOOK IS ORGANIZED

Ten Years of SARE showcases the accomplishments of a unique USDA program that has made a difference in the lives of farmers and ranchers across the United States and Island Protectorates.

To select a group of innovative, interesting and impactful projects, SARE staff chose one project from each of its four regions for the following 10 categories: Crop Production, Animal Production, Natural Resource Protection, Marketing, Community Development, Education, Pest Management, Horticulture, Professional Development, and Integrated Farm/Ranch Systems.

Project features in each of those categories make up the heart of the book. To provide a snapshot of how much SARE has spent in each area, categories are displayed graphically on page 5. A listing of all SARE projects funded from 1988 to 1997 begins on page 86.



LETTER FROM THE DIRECTOR

Since 1988, USDA's Sustainable Agriculture Research and Education (SARE) program has made great strides toward increasing scientific understanding and promoting practical uses to manage sustainable agriculture systems.

In the past decade, SARE has funded close to 1,200 projects that examine how to improve profitability, protect natural resources and foster more viable communities across the nation and U.S. Island Protectorates. Most of the projects were led by university-based researchers—working in concert with farmers, ranchers and Extension educators—who added an "on-the-ground" pragmatism to the science. As the program matured, producers, Extension educators and nonprofit organizations began leading their own projects.

We wish we had more space to devote to the many successes of the SARE program that have directly impacted farmers and ranchers. SARE's work in soil management, cover crops, integrated crop and livestock systems, management-intensive grazing, pest management and innovative horticultural practices truly has made a difference on the agricultural landscape. Here is just a sampling:

- An Oregon vegetable farmer found better sweet corn yields after using a variety of cover crops, then strip-tilling corn into the cover residue the following spring, a set of practices he learned by working with a SARE researcher. (See p. 68)
- In Indiana, an Extension agent and former conventional corn-and-soybean farmer is converting to an organic vegetable operation to realize more profits and a better relationship with the community after attending a SARE-funded professional development workshop. (See p. 70)
- A Vermont couple replaced synthetic herbicides with weed cultivation in their field corn after learning about profitable dairying strategies from a SARE project creating case studies of successful, sustainable dairy farms. (See p. 80)
- Researchers in Virginia dramatically decreased nutrient loading and sedimentation entering a New River tributary by setting up spring-fed watering troughs as part of a SARE study on management-intensive grazing for cattle. (See p. 82)

SARE operates on principles of inclusion, partnership and participation. Not only does each project include farmer input, but farmers and ranchers participate on technical review committees and administrative councils made up of a diverse group of ag professionals in each region. Those committees and councils assume responsibility for recommending a slate of projects each year that best meet the needs of each SARE region.

Partners in the sustainable agriculture movement, from representatives of nonprofit conservation organizations to colleagues at federal and state agencies, have lent their expertise to this process. And a participatory approach that began as an innovation in 1988 has become a proven—and emulated—model 10 years later.

While this 10-year anniversary is a time for some well-deserved praise to the hundreds of people who have been involved with SARE, many challenges remain on the path toward agricultural sustainability.

How should SARE undertake research and education in the context of whole-farm systems?

How can SARE incorporate appropriate uses of new technology, such as precision agriculture?

In what ways can SARE enhance and build new partnerships to enhance sustainable agriculture?

Can SARE have an impact beyond the farm gate to address watersheds, community food systems and other issues of importance to the public at large?

And finally, how can SARE continue to influence conventional agriculture to become more sustainable?

Answering some of those difficult questions will certainly keep SARE and its many collaborators challenged through the next decade and beyond.

Jill Auburn
SARE Director
March 1998

ABOUT SARE

SARE — the USDA's Sustainable Agriculture Research and Education program — works to increase knowledge about practices that are economically viable, environmentally sound and socially acceptable. To advance such knowledge nationwide, SARE administers a competitive grants program first funded by Congress in 1988.

Regional administrative councils recommend projects to be funded after proposals go through technical peer review. The diversity in membership of the regional administrative councils reflects SARE's commitment to serve the broad agricultural community.

While producers always had a role in SARE-funded research projects, SARE began offering a small grants program for farmers and ranchers to run their own on-site research experiments in 1992. Since then, producers have responded eagerly to the program, conducting research and serving as emissaries who carry information about sustainable agriculture to their peers.

SARE devotes significant resources to ongoing outreach projects. The Professional Development Program (PDP) provides education and outreach strategies for Extension educators, Natural Resources Conservation Service staff and other agricultural professionals who work directly with farmers and ranchers. With its emphasis on teaching the teachers, PDP speeds the flow of sustainable agriculture methods and concepts to the field level.

The Sustainable Agriculture Network (SAN) disseminates information about SARE and sustainable agriculture through electronic and print publications. SARE's strong educational component is a cooperative effort of university, government, farm, business and nonprofit organizations to determine information gaps and set priorities for print and electronic products. SAN also sponsors a sustainable agriculture mail group on the Internet and provides much of its information on diskettes with built-in search engines.

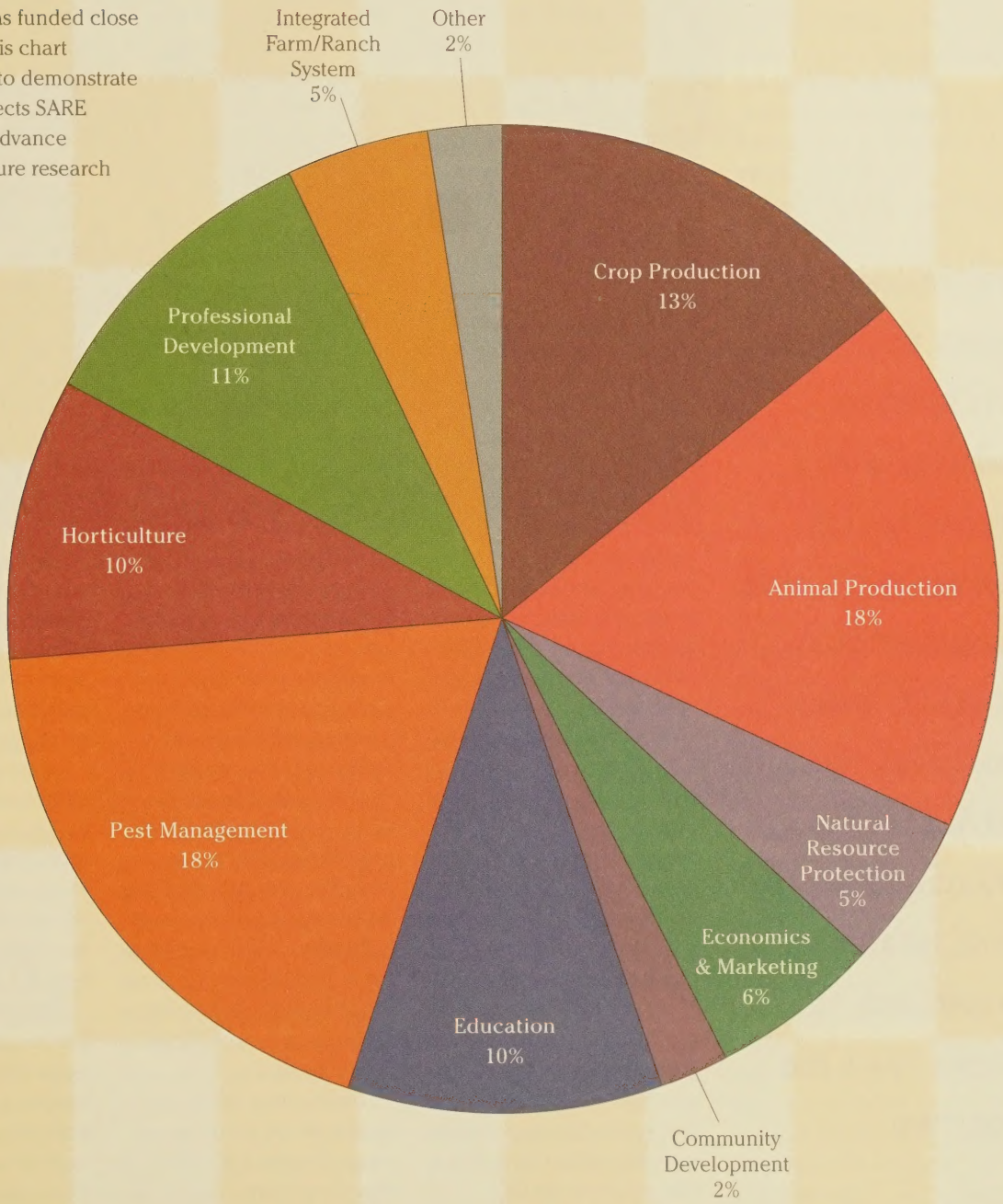
RESEARCH AND EDUCATION GRANTS:
Awarded since 1988, these grants typically fund projects — generally ranging from $30,000 to $200,000 — led by universities or nonprofit organizations in an interdisciplinary approach.

PRODUCER GRANTS:
Producers apply for on-farm research experiments that typically run between $500 and $10,000.

SARE PROFESSIONAL DEVELOPMENT PROGRAM GRANTS:
First funded in 1994, these grants sponsor professional development in sustainable agriculture concepts and practices, using workshops, tours and meetings for Extension, the Natural Resources Conservation Service and other agricultural professionals.

SARE PROJECTS, BY CATEGORY

Since 1988, SARE has funded close to 1,200 projects. This chart categorizes that list to demonstrate the diversity of projects SARE has undertaken to advance sustainable agriculture research and education.



In the mid-1980s, producers seeking ways to conserve soil without sacrificing yields or profits began to look at ridge tillage. Some farmers wanted to combat erosion. Others desired an alternative to reduce the fuel and machinery maintenance expenses associated with the several tractor passes required for conventional tillage.

PROPONENTS OF RIDGE TILL TOUT ITS ENVIRONMENTAL AND PROFITABILITY ADVANTAGES OVER CONVENTIONAL TILLAGE, WHICH REQUIRES THREE TO FIVE TRACTOR PASSES TO PREPARE THE SEEDBED—COMPARED TO RIDGE TILL'S ONE OR TWO.

First developed in the 1950s, ridge tillage features minimum soil disturbance. Farmers plant their crops into four- to eight-inch ridges, and the soil remains undisturbed from harvest to the next planting. During the production season, ridge-till farmers control weeds with cultivation and minimal use of herbicides.

Ridge-till proponents tout its environmental and profitability advantages over conventional tillage, which requires three to five tractor passes to prepare the seedbed—compared to ridge till's one or two. Ridge till also goes hand-in-hand with "banding" herbicides for weed control, offering farmers the opportunity to dramatically decrease chemical application by concentrating spraying on the ridges rather than on the entire field.

While interest was high, producers lacked the real-farm management information they needed to abandon traditional tillage systems. They worried the conservation tillage technique would not provide as good a seedbed as deep tillage had.

"As sustainable agriculture gathered momentum, people began to combine practices and technologies in new ways in the search for sustainable cropping systems," says Rick Exner, who in 1992 received a SARE grant to conduct on-farm research and demonstration of ridge tillage. "We had pieces before that, but we didn't really have systems."

Over four years, 29 farmers working in tandem with university researchers conducted more than 140 replicated on-farm trials involving ridge tillage and ways it could be incorporated into working production systems. Their research provided an information base and demonstration sites for farmers and researchers, becoming a much-needed focal point from which producers could learn how to adapt ridge tillage to specific, on-farm situations.

Unlike many traditional models where university scientists conduct research at experiment farms under controlled conditions, the project's trials were designed and conducted by farmers, many of them affiliated with Practical Farmers of Iowa (PFI).

PFI, a nonprofit, farmer organization, encourages on-farm research of profitable, environmentally sound agricultural practices. Many of its members raise corn and soybeans that, in the past, required extensive tillage. Researching and demonstrating ridge tillage was a good fit for many of the farmers, who wanted to investigate how to grow such crops with ridge tillage and realize its potential benefits. Specifically, they wanted to learn about various methods of fertilizer placement, cover crops and other factors that would help make their systems more environmentally sound without giving up profits.

"A lot of sustainable agriculture is management critical," Exner says. "If you want to find the potential of a system, you have to go where the practitioners have the management skills to make it work."

The SARE grant helped provide the farmers the opportunity to develop ridge tillage-related practices, measuring their success through replicated field comparisons. The ridge-till trials also attracted several ISU scientists, who extended those studies

PLANTING CROPS INTO 4- TO 8-INCH RIDGES HELPS FARMERS REDUCE THE AMOUNT OF HERBICIDES THEY SPRAY TO CONTROL WEEDS. PHOTO BY T.L. GETTINGS/RODALE IMAGES.

through their own research.

When Exner and the farmer-researchers examined the results of four years of research, they found:

- Ridge till compares very favorably with other tillage systems for yields while lowering cost of production. While more management-intensive than other systems, it proved to be very profitable on a per-acre basis.
- Ridge till is compatible with frugal use of herbicides, including eliminating it altogether, reducing rates through banding and alternative measures such as rotary hoeing, cover cropping and cultivation.
- Ridge till offers more weed management flexibility than no-till, letting producers integrate more sustainable practices and limiting the need for "rescue" herbicide treatments.
- Even though spring release of soil nutrients is delayed in ridge till, the practice is compatible with the pre-sidedress soil nitrate test used for corn in Iowa and some other states.

Information learned through the PFI and SARE on-farm ridge tillage research continues to contribute to the development of more sustainable systems. Today in Iowa, ridge tillage has gained favor by those sustainable farmers producing organic and herbicide-free soybeans, which garner premium prices $3 to $10 higher than regular soybeans in the world market.

"Individually, we've all satisfied some of our goals and doubts by what we've looked at and learned," says Ray Stonecypher of Floyd, Iowa, one of the farmer participants.

Stonecypher studied ridge tillage with and without herbicide, with different nitrogen rates, with dry and liquid fertilizer and with different equipment modifications, and learned he could reduce his herbicide and fertilizer use while maintaining yields.

One of the best aspects of the project was developing solutions in concert with university researchers, says Richard Thompson, who examined potassium uptake and how the use of ridge tillage facilitated more sustainable rotations as part of the project. Thompson of Boone, Iowa, remains a national leader in ridge tillage and on-farm research.

Perhaps most important, the project allowed producers to establish communication ties with other farmers around the state interested in trying ridge tillage innovations, lessening the pressure associated with "being different" in the local farming community.

By its very design, ridge tillage makes on-farm research more inviting to farmers, Exner says, because the ridges facilitate row identification and marking and make it easier to track treatment areas from one year to the next.

Ridge till also offers farmers an opportunity to test and incorporate such practices as intercropping and deep placement of fertilizer. Placing fertilizer three to five inches below the top of the ridge allows for reduced fertilizer use and fall application, while still providing all the benefits of traditional fertilizer application.

—Lisa Jasa

Before the advent of herbicides, row crop farmers cultivated their fields with various mechanical devices to kill yield-reducing weeds. When agrichemical use intensified in the 1950s, farmers abandoned their hoes and tines to take advantage of a solution that promised total weed control with a pass or two of an herbicide-spraying tractor.

Decades later, producers learned chemical weed controls had the potential to degrade streams and rivers or seep into the groundwater. Today, the pendulum has begun to swing back in some regions as crop producers seek viable alternatives to expensive herbicides.

THEIR PRIMARY FINDING: FARMERS CAN COMPLETELY CONTROL WEEDS USING CULTIVATION, ALTHOUGH COMBINING CULTIVATION WITH A SMALL AMOUNT OF HERBICIDES MAY BE A BETTER WAY TO MANAGE TIME AND MAINTAIN YIELDS.

"Farmers are feeling pressure from their neighbors about the amount of spraying they do, and they have economic concerns as well," says Jane Mt. Pleasant, a Cornell University researcher who led a SARE project testing mechanical alternatives to herbicides. "Many farmers think it's better for the land—they feel stewardship toward their land and think we need to be acting more carefully. Cultivation seems to be one way of doing that."

The project explored ways to eliminate herbicides as well as ways to reduce herbicide use without affecting crop yields. Over five growing seasons, Mt. Pleasant and colleagues Charles Mohler, Robert Burt and graduate student James Frisch tested mechanical weed control strategies on field corn at Cornell research stations and at three New York farms.

Their primary finding: Farmers can completely control weeds using cultivation, although combining cultivation with a small amount of herbicides may be a better way to manage time and maintain yields with the least risk.

The researchers found differences of less than $5 an acre when they compared the production costs of broadcasting herbicides against cultivating. When they focused on net returns from corn yields, which can be affected if untreated or uncultivated weeds crowd out the corn, they found integrating chemical and mechanical weed control posed the least economic risk for growers. Those trying cultivation exclusively could see yield reductions of 5 percent to 10 percent.

Cultivating requires additional passes across the field. Most conventional corn growers currently make only one or two passes for weed control. Switching to mechanical cultivation could require as many as four or five tractor passes, time and expense few farmers can afford. Combining herbicide banding—which applies chemicals in narrow "bands" over crop rows—with cultivating often is the best option for most farmers, Mt. Pleasant found.

Organic farmers who use no synthetic chemicals can pass on their additional costs by charging a premium for their corn. Kathie Arnold, who grows 55 acres of corn for organic grain to feed to her dairy herd in Truxton, N.Y., replaced herbicides with cultivation in the 1997 season.

Her reasoning was partly economic; she receives about $19 per hundred weight for organic milk compared to about $11 for conventional. But Arnold also describes her "conservation ethic," harboring concerns about the

USED PROPERLY, THIS ROW CROP CULTIVATOR CAN REPLACE ALL OR MOST HERBICIDES SPRAYED TO REDUCE WEEDS. PHOTO COURTESY OF NORTHEAST REGION SARE.

runoff from her farm, located in the Cheapeake Bay watershed via the Tioughnioga and Susquehanna rivers.

"We'd done some cultivating and banding in the past, but this year, we decided to transition the whole farm to organic production," she says. "The corn looked as good as any we've seen, although I spent a lot of time on a tractor this summer, cultivating."

Arnold took two extra tillage passes before planting to remove any weeds already present in the soil, then cultivated between the corn rows once or twice during the growing season.

For other producers, it may make most sense to reduce herbicide use—up to 65 percent, Mt. Pleasant says, without a reduction in yields—by incorporating mechanical cultivation into the crop rotation.

"The audience we want to target are conventional growers who are relying on chemical control and find ways for them to substantially reduce use of herbicides without substantially changing their management, their equipment or their yields," Mt. Pleasant says. The system "requires some change, but it's a much easier sell than asking all farmers to throw out all their herbicide sprayers and rely totally on cultivation."

The project also examined different cultivation tools for corn growers, from rotary hoes to tine weeders to row crop cultivators. While different mechanical tools work best in particular settings, Mt. Pleasant stressed that cultivating devices available today are a far cry from weeders of old.

"These are not the same tools farmers' parents used," she says. "There is a large array of choices and the tools are much improved."

Farmers who want to cultivate exclusively will want to include tine or rotary hoes as well as standard row-crop cultivators. Other farmers might benefit most from cultivators. The type to buy—rolling versus no-till or S tine—is site-specific.

Tillage remains a key component in weed control. A farmer wishing to cultivate to control weeds will till, plant, then cultivate. If he or she has minimally tilled the field to help control erosion, it will be harder for some cultivating tools to penetrate the plant residue left on the surface. Standard cultivators are out; instead, farmers need to invest in a high-residue cultivator.

One of Mt. Pleasant's more surprising results came when she experimented with cultivation timing. Conventional wisdom suggests that farmers control weeds at a specific time in the plant's life cycle, but Mt. Pleasant found more flexibility without sacrificing weed control and, ultimately, crop yields. Modern field corn varieties, leafy and vigorous, act as effective competitors for soil nutrients, sunlight and water against weeds.

"If you let the weeds go, they will substantially reduce yields," she says. "But the idea that they have to be controlled in a certain small window is false. It's much wider than we had thought."

—*Valerie Berton*

In the early 1940s, lupins were grown extensively across the South as a nitrogen-fixing cover crop for cotton. In its heyday, lupins spread across 2.5 million southern acres.

Today, the legume is rarely used by farmers. When chemical fertilizers gained popularity following World War II, lupins lost their niche as a cover crop. The consuming public, too, has turned away from a nutty, nutritious foodstuff similar to lentils.

Don't write off lupins so fast, says USDA Agricultural Research Service (ARS) soil researcher Wayne Reeves, who came across old literature on the legume while searching for alternative crops to incorporate into sustainable cropping systems in the South. In what he touts as a viable alternative to its widely planted cousin—soybeans—lupins hold great potential both as an animal forage and as a product for human consumption.

The write-up piqued his interest in further studying lupins in rotation with common commodities like wheat and soybeans, as well as alternatives such as pearl millet and tropical corn. Reeves, with help from collaborators, obtained a SARE grant in 1993 to test the viability, profitability and resource-conserving potential of lupins in combination with other field crops.

Lupins, pearl millet and tropical corn embellish traditional crop rotations by extending the growing season. Lupins can over-winter while tropical corn and pearl millet can be planted in late spring/early summer for a late harvest.

"Lupin provides an option to grow a feed grain in winter," Reeves says. It shares the high protein content of soybeans, but is easier to process. "A farmer can crush lupins on site without having to buy back a processed feed like soybean meal. You just grind it to crack the hard shell, mix with feed, and you have a good high-protein feed source to use on farm."

As a legume, lupins help fix nitrogen, a real plus in the South, which faces more fertility challenges than

LUPIN, A PROTEIN-RICH FORAGE AND COVER CROP, HELPS INCREASE TROPICAL CORN SILAGE YIELDS, GENERATING INTEREST FROM FARMERS ACROSS THE SOUTH. PHOTO COURTESY OF AUBURN UNIVERSITY.

other regions. Its wet, warm winters cause denitrification, and its sandy soils facilitate nitrogen leaching.

Working with researchers at Auburn University, the University of Florida and USDA-ARS researchers in Georgia and at the National Soil Dynamics Lab in Auburn, Ala., Reeves tested six cropping systems that included lupins, tropical corn and pearl millet. Reeves was most impressed by the lupins' ability to fix nitrogen.

At one location, lupin acted as an efficient "green manure" that resulted in tropical corn silage yields of 20.5 tons an acre. Those results have generated interest from cotton growers in the Florida panhandle, southern Georgia, Alabama, North Carolina and South Carolina. Growers want to take advantage of a cheap, efficient way of adding nitrogen without setting the stage for water contamination problems that can occur with excessive use of purchased fertilizer.

Lupin's potential as an animal feed or forage and for human food was limited in his experiment by plant genetics, Reeves says. The lupin variety the researchers used proved too sensitive to fungal diseases when planted in spring and summer. The optimum variety would mature earlier — in May — to allow another crop, such as tropical corn, to follow during the summer growing season.

The researchers plan to follow up the "intense interest" in using lupin as a cover crop by encouraging seed companies to stock and market two varieties that show most promise. They also are producing a lupin video and management guide.

Tropical corn provides an opportunity to follow lupin in late spring, unlike standard field corn, which southern growers plant in April to reduce the potential for insect damage that can occur when the crop is planted too late. Tropical corn, bred in tropical climes, exhibits a tolerance to common southern pests like armyworm, says David Wright, Extension specialist for agronomy at the University of Florida and a cooperator on the SARE project.

Those findings alone could have a significant impact on southern growers, who could work tropical corn into wheat and soybean rotations. Indeed, the total acreage of tropical corn went from about 3,000 acres 10 years ago to close to 100,000 today, partly a "direct result of the work we have done on tropical corn," Wright says.

Not only did tropical corn yields benefit from following lupin, but pearl millet also performed well behind the legume. At one location, millet yields equalled 129 bushels per acre, with lupin supplying about the equivalent of 60 pounds of applied nitrogen. Millet holds perhaps the most potential as a successful forage alternative in the South because of its drought-tolerance.

Pearl millet is a high-protein grain, measuring between 12 and 14 percent compared to corn's 9 to 10 percent. Pearl millet, therefore, makes a nutritious feed grain for livestock, particularly poultry, appealing to producers across the country who have called Georgia Experiment Station researcher Wayne Hanna for information.

Hanna advocates pearl millet for southern rotations because it survives heat and drought stress. He speculates the grain adapted to such conditions because of its likely origin in tropical Africa.

"We have to ship grain in from the Corn Belt," Hanna says. "Our idea was to come up with an alternative crop that likes the droughty, acid soils of the South, and pearl millet fits the bill."

LUPIN ACTED AS A "GREEN MANURE," A CHEAP, EFFICIENT WAY OF ADDING NITROGEN WITHOUT SETTING THE STAGE FOR WATER CONTAMINATION PROBLEMS THAT SOMETIMES OCCUR WITH EXCESSIVE USE OF PURCHASED FERTILIZER.

Its ability to withstand African-style heat means pearl millet can grow in late summer. It can be planted as late as mid-July, seemingly thriving in hot, dry periods.

"This crop can be planted after you harvest wheat or canola at the end of May and June, when you can't come in with any other grain crop," Hanna says. "It's not sensitive to the day length and has a short maturing season."

— *Valerie Berton*

Both supporters and skeptics in California's Sacramento Valley wondered how sustainable agriculture farming systems would fare compared to conventional in the first large-scale, head-to-head competition of its kind in the nation's most productive agricultural state.

A decade later, people are still intrigued by the comprehensive SARE-funded research project, but what farmers really want to know is how they can incorporate some of the profitable, environmentally friendly techniques identified in the UC-Davis study.

LOW-INPUT CORN, GROWN WITH HALF THE CONVENTIONAL AMOUNT OF PESTICIDES AND MUCH LESS SYNTHETIC FERTILIZER, CONSISTENTLY RANKED FIRST IN BOTH YIELDS AND PROFITS.

"Now we don't ask whether low-input and organic production is viable," says Bruce Rominger, a Yolo County farmer who raises vegetables and field crops and acts as an adviser for the project. "We know it's viable. We're just trying to perfect it."

Information gleaned from the long-term Sustainable Agriculture Farming Systems (SAFS) project—from feeding soil with cover crops to growing more corn with fewer pesticides and synthetic fertilizers—could help producers like Rominger make a transition to alternative production techniques.

While typical agricultural research studies last two to three years, the SAFS project, now celebrating its 10th anniversary, will run for 12 years. The research compares conventional, low-input and organic cropping systems for tomatoes, corn, safflowers and beans based on pest populations, soil health, crop yields and economic viability.

Researchers are encouraged by the economic potential of crops grown with reduced chemical inputs. Low-input corn, grown with half the conventional amount of pesticides and much less synthetic fertilizer, consistently ranked first in both yields and profits.

In a 1997 comparison, price premiums for organic crops pushed their net returns to $292 per acre, just under the top-ranking, two-year conventional rotation's returns of $305 per acre. Aside from profits, researchers worry that long-term conventional production has the potential to increase disease and degrade soil.

Along with researchers ranging from agricultural economists to water scientists, farmers and Extension specialists are involved in every step of the project. "After all, farmers have always been our foremost experimenters," says Steve Temple, the crop production researcher who leads the project.

The project combines rigorous research with real-world management. The rigor can be found in the 56 carefully managed, one-third-acre plots on the university's agronomy farm. As for the realism, all systems are managed to make a profit, using best farmer practices.

Researchers are studying four different production systems, comparing a two-year conventional rotation of processing tomatoes and wheat to four-year rotations of tomatoes, safflower, beans and corn grown using conventional, low-input and organic practices.

Conventional management follows typical farming practices in the Sacramento Valley, using synthetic fertilizers and pesticides. Low-input management includes cover crops and supplemental min-

WORKERS AT THE UC-DAVIS AGRONOMY FARM HARVEST TOMATOES BY HAND TO VERIFY YIELDS IN THE SAFS PROJECT. PHOTO BY JACK KELLY CLARK.

eral fertilizers, as well as pesticides, when warranted. Organic rotations are free of synthetic chemicals and meet state organic certification standards.

Researchers have wrestled with problems common in making a transition from conventional to alternative practices.

To find solutions, researchers get creative at an eight-acre area adjacent to the test plots, nicknamed the "playground," where they test new management ideas before incorporating them into the 56 long-term research plots. Some of the ideas—such as mounting a propane flamer on the tractor for weed control or using weed-eating geese to cut the costs of hand-hoeing—are admittedly offbeat. But the brainstorming has provided some serious improvements in the research.

For example, in the cold spring weather, cover crops and composted manure don't always break down early enough in the season to supply crops with nitrogen, reducing yields.

One solution to nitrogen deficiency was to irrigate fast-growing grass and grass/legume cover crop mixtures in the fall to build nitrogen early enough to help crops in the spring. Another playground idea that bore fruit was using tomato transplants instead of seeding in low-input and organic systems. Transplanting gave cover crops longer to grow and increased yields. Direct-seeded tomatoes should be planted about Feb. 15, while transplants can be planted as late as April 10, allowing time for the cover crop to accumulate more biomass and fix nitrogen.

To help farmers compare the bottom line for each rotation, economists use actual input costs, crop yields and market prices to model returns for hypothetical 2,000-acre farms.

Except for weeds, which accounted for 25 percent of operating costs, significant pest problems did not emerge with alternative management. But the high labor costs for hand hoeing tomatoes considerably raised the costs of growing low-input and organic systems.

Overall, the four-year rotations have shown comparable returns over the years, though each has strengths and weaknesses. Because processing tomatoes are the most profitable crop, a two-year conventional tomato/wheat rotation won out economically, though the production system raised concerns about the potential for increased disease and soil degradation. A conventional four-year rotation has the lowest costs, but not the highest returns. Reduced pesticide use in the alternative rotations lowered input costs and the risk of groundwater contamination. Alternative methods also improve soil structure, along with its ability to take in water and nutrients.

Low-input systems, on the other hand, produce well but have higher costs than conventional. Organic production, the most expensive, also showed the best profits in 1997, if current price premiums were factored in.

Rominger, who uses both conventional and organic methods on his farm, says the project's results can be applied in the real world. It's helped him learn "volumes" about soil science and given him the idea of using transplants with organic tomatoes.

"We can take risks that farmers can't," says Sean Clark, the research manager. "We want to be a proving ground for what works."

—D'Lyn Ford

CHANGING TO MANAGEMENT-INTENSIVE GRAZING ENABLED THEM TO INCREASE THEIR HERD SIZE, BUT LEAVE ENOUGH GRASS TO MAINTAIN AND IMPROVE THE PRAIRIE RESOURCE AND WILDLIFE HABITAT.

On a foot tour of the Woodburys' eastern North Dakota rangeland in 1997, a neighbor observing the lush prairie vegetation shook his head in amazement.

"Didn't you guys graze this pasture this year?" he asked.

Larry Woodbury, who, with his wife, Judy, and the help of a SARE producer grant, had overhauled his grazing system to improve profits and protect wildlife habitat, answered in the affirmative. While the grass looked as lush and healthy as any ungrazed land in the wide-open range of eastern North Dakota, the couple had grazed that pasture twice.

It was obvious the long, hot hours the Woodburys had spent putting up nine miles of fence and moving cattle between 17 different pastures every few days had paid off. Even running 29 percent more cattle—measured in "animal unit months," or the feed a 1,000-pound cow consumes in a month—than the year before, the Woodburys and Larry's brother, David, were improving pasture and increasing the wildlife habitat on their 3,000 acres near McLeod, N.D.

"The best thing about this project has been showing the neighbors what potential we have here and to prove we can do it working together as a family," says Larry Woodbury, who has been a rancher his whole life.

In addition to their 3,000 acres of owned and rented cropland, hayland, pasture and native range, the Woodburys hold a grazing permit on the Sheyenne National Grasslands.

Before changing their traditional operation—a 175-pair cow/calf herd, with an additional 270 yearling bred heifers—to 958 yearling heifers who run the range under management-intensive grazing until they are ready for the feedlot, the Woodburys worried about the bottom line as well as the condition of the range ecosystem. Cool-season grasses and undesirable forbs such as goldenrod were invading the pastures, crowding out warm-season natives. Willows and other woody plants unpalatable to cattle were taking over low areas.

The change enabled the Woodburys to make a profit when cow/calf operations were losing money. Even with the increase in their livestock, utilization figures showed they were leaving enough grass to maintain and improve the prairie resource and increase wildlife habitat.

"We knew we had to do something different than what had been done for years and years," Judy Woodbury says. "But we weren't sure exactly what we should do."

At a range association meeting, Lynn Wolff, secretary of the local grazing association, signed the Woodburys up for a Holistic Resource Management (HM) course, which offered information on management-intensive grazing as well as more philosophical concepts, such as livestock's connection with the landscape. After attending the three-day course, the Woodburys were eager to try the non-traditional HM rotational grazing system.

"I went to the workshop not knowing what to expect," says Judy Woodbury, a registered nurse. "I thought 'This isn't about farming, this is about life. This is about how to make a better life on your land.'"

She applied for a SARE producer grant to help transform their rangeland into a well-managed series of pastures full of nutritious grass and legumes and plenty of shelter for wildlife. Though the Woodburys had never written a proposal before, their project was funded in 1995.

The Woodburys began fencing off the land and, by

THE WOODBURYS ALLOW GRAZED PLANTS UP TO TWO AND ONE-HALF MONTHS TO RECOVER FROM THE CATTLE HERD TO RESUSCITATE THE PRAIRIE. PHOTO BY JUDY WOODBURY.

1996, had created 17 pastures varying in size from 36 to 320 acres.

Cattle spend two to 11 days in each pasture, allowing grazed plants 60 to 80 days to recover before the animals return. When grass is growing rapidly, the Woodburys can quickly move cattle to new pasture so they won't graze the grass regrowth. This system not only lets the grass replace the food reserves in its roots, but it also gives other valuable plants time to grow and complete their life cycles.

Bernadette Braun, range specialist with the U.S. Forest Service at the Sheyenne National Grassland, shared their concern about native habitat. Braun, who taught the Woodburys more about grassland species and biodiversity, was excited by the discovery of prairie fringed orchids on the couple's leased land. In 1994, she found six of the endangered native orchids. The following year, Braun catalogued 300, and in 1996 she counted 1,200.

"The Woodburys have so many pastures, they can leave one with orchids in it ungrazed until the orchids have completed their cycle," says Braun, who speculates the mini-population explosion can be attributed in part to the Woodburys' rotational grazing system.

Rotations also can benefit wildlife, Braun says. Some of the Woodburys' land is prime nesting habitat for the greater prairie chicken. With rotational grazing, that habitat can be left undisturbed while the birds nest.

As a result of their HM education, the Woodburys also have converted 250 acres of highly erodible cropland to alfalfa and smooth bromegrass. After haying that acreage for a few years, the pastures will become part of the grazing system. Another 50 acres have been planted in native grasses.

"It's supposed to take five years or so of rotations to really see a difference, but we can already see our grass improving," Judy Woodbury says.

The Woodburys do not preach to their neighbors about their new system, but they aren't shy about sharing their ideas. In 1996, their operation was a featured attraction on a six-county summer range tour sponsored by the NRCS, the U.S. Forest Service, the Lake Agassix Project and the local HM work group.

The Woodburys and other area ranchers who attended HM workshops have formed a work group to implement new ideas and discuss and monitor their rangelands. The group has sponsored three "Introduction to Holistic Resource Management" workshops, although the Woodburys remain realistic about the pace of change on the prairie.

"You can't talk anybody into anything," Judy Woodbury says. "I should just stand on a fencepost and take a picture. The neighbor's side looks like a golf course and our grass is really thick and tall. Seeing something like that is what will convince people to try something new."

— *Monica Norby*

When Travis Forgues left home for college six years ago, he had no intention of coming back to his parents' dairy farm in Alburg Springs, Vt. "My parents were on a dead-end road, and there was no financial way I could come back, even if I wanted to," he says.

Instead, he studied psychology, intending to work with emotionally disturbed youth. But after Henry and Sally Forgues switched from a confinement system to grass-based dairying, Travis, now 24, changed his mind. He makes no bones about why.

"Grazing management saved this farm," he says. "Without it, this farm wouldn't be here, and I definitely wouldn't be here. Grazing has been the real focal point of our farm's profitability and cohesiveness."

The catalyst behind the Forgues' new direction, as well as many other New England farmers, was William Murphy, University of Vermont agronomist and one of the earliest advocates of management-intensive grazing (MIG). Murphy believes MIG could help farms be more profitable and cause less stress for farmers.

"Farm-family quality of life improves drastically when farmers make the switch, and this is extremely important," Murphy says. "No matter how environmentally beneficial a farming practice is, if it doesn't benefit the farm family, it won't be used."

In 1988, Murphy received one of the first SARE grants to study the profitability of grass-based farming. But when he started his research, he hardly knew how to begin.

Along with a few other Vermont farmers, Murphy had been grazing his own animals for a few years. But there had been little or no research into the effects of intensively managed grazing on livestock

GRAZING LIVESTOCK ON WELL-MANAGED PASTURES CAN INCREASE AVERAGE NET INCOME PER ANIMAL. PHOTO BY WILLIAM MURPHY.

"FARM-FAMILY QUALITY OF LIFE IMPROVES DRASTICALLY WHEN FARMERS MAKE THE SWITCH" TO GRAZING. — WILLIAM MURPHY

production anywhere in the nation. Early in the project, Murphy had the opportunity to travel to Ireland — where climate conditions are similar to Vermont — to learn from researchers and farmers who had been grazing for decades.

Most northern U.S. dairy farmers confine their herds in barns, harvesting and storing, or buying forage to feed the cattle throughout the winter. When animals are let out to graze, the pastures they feed on often are poorly managed.

"Farmers pastured, but they used very minimal management, and usually their feed would run out in July or August, and it was all done for the season," Murphy says.

University agronomists seldom included the effects of animals in their forage studies; instead, they clipped pastures mechanically to simulate grazing. No funding was available for research on grazing, and no wonder, Murphy says.

"Agribusiness can't be expected to fund research that will decrease spending on their products," he says. Most MIG research funding comes from government, foundations or farmers.

MIG rations out pasture forage according to livestock needs while protecting the plants from over- and undergrazing. Large pastures are subdivided into smaller areas called paddocks, which are grazed quickly by a high concentration or stocking density of livestock. As soon as the plants are grazed, animals are moved to a fresh paddock to prevent overgrazing.

Under this kind of management, pastures usually change to a nutritious mix of grass and legumes that grow well and reseed naturally. Fields that used to offer a few months of skimpy grazing now grow lush forage from May through October. They furnish livestock farmers with much more feed, reducing costs for purchased feed, labor, machinery and other inputs.

Farm families spend less precious time putting up forage and feeding cows and have more time for other farm chores or to spend with their families.

A two-year economic analysis showed that, among nearly two dozen pasture-based farms, the average net cash income per cow was $600, compared to $450 per cow for the top 25 Vermont dairy herds raised in conventional confinement systems. Those savings are mainly credited to lower costs for fertilizer, seed, machinery and labor.

Since Murphy began his research, the number of farmers intensively managing pastures, called graziers, has grown from just a handful to about 300 in Vermont alone. The tremendous growth of pasture-based farming hasn't been just in Vermont. In Wisconsin, partly as a result of some of Murphy's earliest pasture workshops, grazing has increased greatly.

One of the biggest benefits of the project has been the way MIG brings farmers together to share knowledge and ideas. Early on, Murphy formed a grazier support network of more than 50 farmers to hold discussions and pasture walks. The network now includes sheep, beef, goat and poultry producers, as well as dairy. It also helped spark formation of the Vermont Grass Farmers Association in 1996. Several grazing conferences now are held annually in northern New England.

Murphy and others want to persuade more Northeast dairy producers to consider trying the system. High-input farming makes no sense in an era of low commodity prices and high inputs costs, Murphy says, especially since the Northeast has ideal soil and climate conditions for pastured-based farming.

More pasture-based farms means less use of pesticides and fewer concerns about manure and soil erosion. Perhaps most important, Murphy says, MIG could help keep rural America vibrant.

"Farms currently in business would be better able to remain in business, and new people would come into farming, so more people would be living on the land," he says.

In the economic and political climate of volatile milk prices, the farmers who survive will be those with little debt and a new outlook, says Travis Forgues, the young dairy farmer.

"I think graziers are going to have the only chance because they don't have the overhead," he says. "It's going to be a different future. But I think there still will be farmers. I'm not going anywhere."

—Susan Harlow

Although it may seem like selling snowballs in Alaska, Laura and Ralph Rogers market and sell fresh chicken to other Kentucky farm families in their rural community. At $5.50 per bird, they get more orders than they can fill in their second year of pastured poultry production.

Theirs is not the first chicken success story from this region of small farms tucked around Daniel Boone National Forest. You can just about toss a plump pullet from their 4R Farm in Woodbine to Colonel Sanders' original restaurant in Corbin. After the Rogers raised their first flock of pastured poultry in 1996, Laura gave Ralph a watercolor print of the Colonel's restaurant in the 1950s to remind him that every big business was once a hometown operation.

UNLIKE CONVENTIONALLY RAISED BROILERS, PASTURED POULTRY ARE NOT FED ANTIBIOTICS AND MOST PEOPLE WHO TASTE PASTURED POULTRY SAY IT IS THE BEST THEY HAVE EVER EATEN.

Why do their rural neighbors buy chicken from the Rogers instead of raising their own or buying it from the grocery store? Taste and tenderness, says Laura Rogers, a savvy business woman who excels at moving a product.

The Rogers raise juicy, broad-breasted Cornish Cross birds developed by the commercial poultry hatcheries to reach slaughter weight in just two months. The broilers grow larger by two months than a Rhode Island Red or other common backyard breed would be at six months. But since Cornish Crosses are slaughtered at such a young age, they are much more tender than other breeds would be at that size.

While the Cornish Cross offer a tasty alternative to other breeds, the heavy birds are not built to range freely around the barn yard. They prefer hanging around a feeder and eating to scavenging like traditional breeds. Their sedentary habits also make them easy prey for dogs, hawks and other predators.

Pasturing them in large movable wire pens has proved very successful. Growing birds choose between the feed trough and a fresh salad of grass all day long. The pen, sometimes called a chicken tractor, is moved once or twice a day, depending on the birds' size. Unlike conventionally raised broilers, pastured poultry are not fed antibiotics since their clean grass and uncrowded conditions promote good health. Living most of their short lives in fresh air and sunlight, they are not fed arsenic compounds to stimulate their appetites. Most people who taste pastured poultry say it is the best they have ever eaten: more tender than backyard chickens and more flavorful than store-bought chickens.

In addition to contributing to bird health, the pasture diet boosts the profit margin. At current feed prices, it only takes $2.25 worth of feed to raise a bird to slaughter weight. The Rogers' retail price of $5.50 per bird provides a comfortable return, even though pastured poultry sells for more than $10 per bird in urban markets. "Farming people are our clientele," says Laura. "I can sell everything we raise because I know what people around here can pay."

Not only does raising poultry on pasture require fewer inputs than conventionally raised chicken, the Rogers appreciate the low output of waste. At the end of every grow out period, confinement chicken operations leave behind a mountain of manure—a potential pollutant for local ground and surface waters. Since pastured pens are moved every day, droppings are evenly scattered over a broad expanse at the end of a growing season. Even the Rogers' children can point out the dark green rectangles of grass where last year's pens sat on newly cleared scrub land.

"With only seven acres to work with, all of our land needs to be in top condition,"

SARAH AND WILLIAM ROGERS, AGES 6 AND 3, ALREADY KNOW HOW TO TALLY INCOME AND EXPENSES ASSOCIATED WITH THE FAMILY'S LIVESTOCK BUSINESS. PHOTO BY GWEN ROLAND.

says Laura. "Those chickens will help it get there with less money and time from us."

The Rogers learned to raise pastured poultry as part of a Southern Region SARE project conducted by Heifer Project International to boost the incomes of small family farms. "By teaching these farm families how to include pastured poultry into their farm plans, we are actually teaching them to diversify their operations and see their farm as a whole system," says Steve Muntz, HPI field representative for Appalachia.

HPI will train 24 families in the three-year project. The Rogers and seven other farming couples were trained in the first year, 1996. They traveled to Joel Salatin's farm in Virginia, where they learned everything from pen construction to chicken processing.

The Rogers lost no time getting started after their training. They built a brooder house and movable pens for their first flock. At processing time, each customer was asked to fill out an evaluation form about the quality and flavor of the chicken. Heartened by rave reviews, the Rogers printed business cards and ordered more chicks. A year after their training, they passed on a gift of 100 chicks and helped train a new family. Nearly two years after training, they are expanding their market.

Once established, pastured poultry require little attention other than moving the pen once or twice a day, depending on the size of the birds. The Rogers found this left them time to develop other low-maintenance, space-saving livestock enterprises such as rattites, ducks, rabbits, bees and a fledgling worm farm. They transfer the sound management principles learned in the pastured poultry training to each new enterprise added to their seven-acre farm.

The livestock also teaches Sarah, 6, and William, 3, about responsibility, the food chain, nutrition, life cycles and money management. "They know when they get up in the morning that the first thing we have to do is take care of the animals," says Laura. "The rabbit business is all theirs. I show them how to keep expenses and income and how to tithe what they make. But best of all, they are learning that a family works best when it works together."

Along with training 24 farm families in pastured poultry production, the SARE project also has helped finance the startup of the American Pastured Poultry Producers Association (APPPA). APPPA and its newsletter, *Grit*, share information among farmers about pastured poultry systems. — *Gwen Roland*

THE STRATEGY OF RAISING CALVES THAT REACH SLAUGHTER WEIGHT IN UNDER ONE YEAR COULD HELP SUSTAIN RURAL COMMUNITIES WHOSE ECONOMIES DEPEND ON THE RANGE LIVESTOCK INDUSTRY.

Rancher Lee Wood feels at home on the cold desert ranges and high mountain meadows of southwestern Utah, working cattle on horseback. The Cedar City cattleman is a sixth-generation rancher, and the fifth generation to ranch in Utah, where his great-great-grandfather settled in the 1870s.

However, Wood knows that with shifts in public opinion and policy, ranchers and cattle may not always be welcome on public lands in the West. "Ranching is a great way of life, and I want to hang on to it," he says. "That's why I'm willing to make some changes and try some new ideas."

Wood is helping a SARE-funded researcher test an alternative to traditional cow-calf production that could help ranchers stay in the cattle business if grazing on public lands is curtailed. Randall Wiedmeier, a livestock researcher at Utah State University, has devised a strategy for raising—on privately owned land—calves that reach slaughter weight in under one year, instead of the usual 18 months or more.

"This is a management-intensive approach that won't work for everyone," Wiedmeier says. "But we believe it can offer a way for ranchers to stay in the cattle business, with the same kinds of returns."

Besides keeping ranchers like Wood in the business they know and love, the approach also could help sustain rural communities whose economies depend on the range livestock industry.

In Utah, where about 70 percent of land is federally managed, an estimated 70 percent of ranchers depend on public lands for some grazing. Most cow-calf producers run cattle on 10,000 to 20,000 acres of public land for five months of the year. Most producers also own a few hundred acres of irrigated pastures and meadows that supply hay.

To stay in business with little or no use of public lands, Wiedmeier says typical producers would have to cut their cow numbers from about 300 to 130 and manage for higher returns per calf. Moving cattle onto private land would reduce hay production, but with fewer animals, less hay would be needed. And having cows in pastures rather than on the range would eliminate the need for daily 50-mile drives to check fences and water.

In small-scale research trials and on-ranch demonstrations, larger-frame, high milk-producing cows were bred to bulls with superior growth and meat characteristics, using artificial insemination (AI). "We're stacking the pedigrees for rapid growth," Wiedmeier says.

AI is unpopular with many producers because it means handling cattle several additional times. Researchers want to investigate whether other breeding methods can achieve similar results.

In the long term, raising all calves for rapid growth would leave producers without suitable replacement heifers for their herds. In general, heifers produced under this system are overly large and lack desirable maternal traits, Wiedmeier says. To produce acceptable replace-

FOR RANCHERS TO STAY IN BUSINESS WITHOUT USE OF PUBLIC LANDS, THEY NEED TO CUT THEIR CATTLE NUMBERS AND MANAGE FOR HIGHER RETURNS PER CALF. USDA PHOTO.

ments, he recommends breeding cows to bulls with strong maternal traits in their early and final years of production.

Under the accelerated beef production schedule, nursing calves receive cereal grain-based feed to boost their growth, starting at 100 days of age. Though feed costs are higher, results are dramatic. "We have a yearling-weight calf at weaning time," Wiedmeier says.

For the final 90 days, ranchers themselves put the calves on a finishing program instead of selling them to a feedlot, a task they were able to take on thanks to a smaller herd size. By retaining ownership of calves until they're sold to a packer, ranchers become their own feedlot managers.

"Calves sold at weaning change hands an average of two times before reaching slaughter weight," Wiedmeier says. "This eliminates the commission ranchers need to pay for resale and allows the cow-calf producer to benefit from superior genetics."

Accelerated growth means calves are ready for market in early February, when slaughter cattle prices usually reach their annual peak.

A critical question is whether beef from the young calves is acceptable to packers and the public. To find out, Wiedmeier sent 10 steers to a packing house, without mentioning his research. "We wanted to know whether these calves would have to be sold for a niche market or whether they would be sold through normal marketing channels. They marketed just fine."

Researchers followed up by feeding the beef to a 50-member consumer tasting-panel that compared the meat's tenderness, juiciness, flavor and acceptability to USDA Choice cuts. Beef produced in the rapid-growth system equaled the competition in all respects. Because the calves were young, their meat was leaner than traditionally raised beef, a trait that may appeal to health-conscious consumers.

Both biologically and economically, the slaughter-weight calf production system is efficient, though it requires more investment and more intensive management from ranchers. Wiedmeier's research over several years suggests it is possible to produce slaughter-weight calves in under a year, with returns comparable to those of a range livestock operation with approximately half the cows.

When compiled, the ranch demonstration project results will offer another measure of how the system works on real ranches in varied locations with different management styles.

Though the demonstration project isn't over yet, Wood is encouraged by what he's seen on his ranch. "This is not a cure-all, but it has potential," he says. "I plan to try it again in the future."

Will Wood's children be the seventh generation of ranchers in the family? He laughs aloud, pleased at the thought. "I'm hoping."

—D'Lyn Ford

Wetlands are an integral part of the agricultural landscape in the Northern Plains. The "prairie potholes" that dot fields across much of this semi-arid region play a big role in recharging groundwater and preventing flooding. They also provide rich habitat for wildlife, particularly migratory waterfowl.

To many farmers, however, wetlands remain a nuisance. It's tough to maneuver large tillage, planting and harvesting equipment around their perimeters. Adjacent cropping areas are slow to dry out in spring, often delaying planting. Venture too close, too early and the soggy soil can mire a big tractor up to its axles in mud.

Fortunately, an interdisciplinary SARE-funded study is showing that what's good for the wetlands and the birds also can be good for a farmer's bottom line.

"Some people think that farm profitability and environmental concerns are always at odds," says Diane Rickerl, an agroecologist at South Dakota State University. "But in this case, they don't compete. They complement each other."

Rickerl headed up a study team that included agronomists, economists, wildlife experts, soil microbiologists and others who exhaustively analyzed the wetlands and farm management on three cooperating farms: a typical conventional farm, a farm in transition to no-till farming practices and an organic farm.

The species richness of waterfowl breeding pairs was greatest in wetlands on the organic farm, researchers found, with 78 bird species present on the organic farm compared to 57 in the conventional system. Wetland plant species also were more diverse.

"All in all, you can see what a wonderful pocket of diversity wetlands are," says Rickerl, who credits South Dakota for retaining about 65 percent of its original wetlands, when other agricul-

CREATIVE FARMERS SEED A MIX OF FORAGES AROUND WETLANDS, ALLOWING FOR BIRD NESTING IN THE SPRING AND LATE-SUMMER GRAZING FOR LIVESTOCK. PHOTO BY DIANE RICKERL.

ALL THREE FARMS WERE LOSING MONEY ON LAND CROPPED WITHIN 75 FEET OF WETLANDS.

tural states in the Midwest have dropped to less than 5 percent.

The nature of the wetlands themselves and the surrounding landscape probably had more effect on wildlife than the farming practices, Rickerl suspects. But the organic farm also benefits wildlife because of the greater diversity of crops that are found in fields adjacent to the wetlands.

Maintaining small fields of different crops in a patchwork pattern on his 1,200 acres preserves diversity for Charlie Johnson, an organic farmer near Madison, S.D., whose operation served as the project's organic test farm. A third of his land is in forages Johnson rotates with small grains, corn and soybeans. In many fields, rye cover crops protect soil that would otherwise be vulnerable to erosion over the snowy winters, and prairie potholes dot the landscape.

The study's economic analyses found that the organic farm is the most profitable of the three systems if the premium prices received by Johnson for his grain and beef are included. If the premiums are ignored, the organic system is the least profitable.

More importantly, it turns out that all three farms were losing money on land cropped within 75 feet of wetlands.

"Attempting to raise crops close to wetlands can be futile," Johnson says. "Rather than investing in a crop there year after year and watching it fail more often than not, a better alternative is to plant permanent vegetation."

Johnson did just that, seeding a forage mix of switchgrass, bromegrass and alfalfa around some of his wetlands. "We leave the spring growth for nesting habitat. Then we graze it or hay it later in summer when our other pastures have dried up," he says. "The wild hay makes excellent feed for our young beef stock."

Not only are those permanent wetland buffers more profitable for Johnson and good for wildlife, but the study team also found them to be effective nutrient filters. Forage vegetation trapped half of the nitrogen and phosphorus that would otherwise have ended up in the wetland, their study found.

"We usually think of wetlands as being the buffer that filters out the nutrients," Rickerl says. "But now we're seeing they're even more efficient if we buffer the buffer with permanent vegetation."

The study team also found that the smaller wetlands ducks prefer are better at filtering nutrients out of water. "That's important because it is the small wetlands that cause so much controversy in the Prairie Pothole Region," Rickerl says, referring to the reluctance of many to leave small pockets of wetland around which they need to drive their heavy equipment.

Where wetlands are farmed through, the soils can become so overloaded with phosphorus that the nutrient can move into groundwater, or flow out of the wetland to contaminate other surface waters, the team speculates. That situation is very unusual for phosphorus, which normally is bound tightly in the soil, Rickerl says.

"What's the effect?" she asks. "No one knows. But the point is that farmers are wasting money by adding phosphorus fertilizer to these areas that their crops can't retrieve."

Wetlands play an important role in storing water and replenishing both soil moisture and groundwater. Forty percent of the water entering wetlands either remained there or moved into the soil or groundwater, researchers found.

Water budgets from the study also showed that 60 percent of the water entering wetlands is runoff from surrounding fields, which has a tremendous potential to be contaminated with nutrients and other ag chemicals.

"That points out the tremendous role wetlands play in the water cycle," Rickerl says. "That's water that we should be using to recharge the soil and groundwater. Without the wetlands we'd be sending it down the river to cause flooding elsewhere."

Rickerl is continuing her efforts with educational programs to help farmers understand that wetlands and profits can go hand-in-hand. "Regardless of the wildlife benefits, our surveys show most farmers still want to drain wetlands," she observes. "We're trying to show that by managing wetlands properly, money and nutrients can stay on the farm."

Johnson already knows that from experience. "Sometimes we forget why the wetlands are there," he says. "With the forage borders, they can be good for wildlife, good for flood control and produce good feed for livestock. You can't ask for much more than that." — *Craig Cramer*

Do you think we're hitting 200 bushels?" shouted Norman Brittingham over the din of the combine as he maneuvered through one of the strips we had marked in his corn field.

I was riding shotgun with a map of the fertilizer treatments we were testing in a cover crop research project on his Maryland farm. We were measuring corn yields to find out if Brittingham's use of cover crops as a non-synthetic fertilizer was an adequate substitute.

EXTENSIVE RESEARCH AND FARM DEMONSTRATIONS HAVE SHOWN THAT A WINTER COVER CROP OF HAIRY VETCH CAN FIX MOST — AND SOMETIMES ALL — OF THE NITROGEN.

Brittingham was one of 10 farmers who collaborated with University of Maryland researchers in a SARE-funded project studying cover crops as a tool to reduce nitrogen pollution in the Chesapeake Bay watershed. The bay, an estuary of national significance, had become a cause celebre among politicians, environmentalists and area residents looking to restore the once-productive fishery.

Morris Decker, a University of Maryland researcher, sought a possible remedy for one of the biggest suspected bay pollutants: nitrogen from crop/livestock farms. He was trying to determine whether Bay-area farmers could reduce their fertilizer use — thereby further lessening their impact on the watershed. My role, as a Ph.D. candidate at the university, was to assist Decker in designing, coordinating and analyzing studies throughout the state.

Brittingham volunteered to test the amount of nitrogen fertilizer we could replace by growing a winter cover crop of hairy vetch just before planting corn. By adding different amounts of fertilizer to the corn, we determined how much of the purchased nitrogen could be replaced by growing the vetch, a legume that "fixes" nitrogen without sacrificing crop yields.

Grass cover crops like rye, wheat and barley take up excess nitrogen in the fall and winter, preventing it from leaching and ending up in the bay. Legume cover crops such as crimson clover, winter peas and hairy vetch "fix" nitrogen by transferring it from air to soil via nodules on their roots.

Mixing grasses and legumes proved a great option. Farmers could realize multiple benefits, including guarding against erosion, preventing nitrogen leaching, adding low-cost nutrients for their crops and providing a water-conserving mulch that helped to increase yields during Maryland's typical hot, dry summers.

"Extensive research and farm demonstrations have shown that a winter cover crop of hairy vetch can fix most — and sometimes all — of the nitrogen required for maximum corn yields," Decker says. "The cover crop mulch conserves moisture, increasing yield by helping the corn use the nitrogen more effectively."

Most of the corn strips in Brittingham's irrigated field yielded 150 to 170 bushels per acre, whether we had applied low or high rates of synthetic fertilizer. That meant hairy vetch supplied most of the nitrogen needed by the corn crop. Brittingham could save on his fertilizer bills, and by applying the right amounts, would not send any extra nitrogen to pollute the bay.

WAITING UNTIL HAIRY VETCH FLOWERS TO INCORPORATE IT INTO THE SOIL MAXIMIZES THE AMOUNT OF NITROGEN THE LEGUME WILL SUPPLY FOR THE NEXT CROP. PHOTO BY ANDY CLARK.

Other cooperating grain or crop/livestock farmers in Maryland planted rye, wheat, barley, crimson clover, winter peas, hairy vetch or mixtures of grasses and legumes. Cover crops protect and improve the soil during a time when no other crop normally would be grown, such as during the winter in the Northeast.

"A vetch/rye cover crop mixture provides more benefits than either one alone," Decker says. "When residual fall soil nitrogen is high, rye will dominate the mixture, but when soil nitrogen is low, vetch will dominate, fixing more nitrogen. This provides producers an excellent management tool."

We had tested those cover crops in very small plots on university research farms and needed to validate our findings in the field. Cooperators used different rates of nitrogen fertilizer to help us tease out more information about how the cover crops affected nitrogen dynamics on a farm scale. Decker also took the opportunity to demonstrate to farmers the value of using cover crops in their operations.

The farmers helped us confirm it usually was best to wait until late April to kill the cover crops, especially legumes or legume/grass mixtures, in preparation for the cash crop. This allowed the legume to fix more nitrogen, and resulted in more cover crop mulch and better moisture conservation. Many farmers like to plant their corn at about this time, so we hoped to show them that corn yields often were better if they waited the extra week or two to realize the full benefit of the cover crop.

On the bay's western shore in Frederick County, Joe Hottel took the fertilizer test one step further. He dedicated more than 90 acres of his diversified crop/livestock farm to test three- to 10-acre strips of cover crops, different fertilizer rates and applications of sewage sludge.

Cover crops could play a role in managing the nutrients contained in the sludge—taking up excess nitrogen in the fall and releasing it back the following year for the corn.

"I like what cover crops do for my soil," Hottel says. "They keep the soil from eroding, which I really like when we get heavy rains. This farm was full of erosion gullies when I took it over. They're all gone now."

By season's end, Hottel's yields ranged from 130 to 160 bushels per acre, comparable to his usual take. Moreover, the combination of cover crops and sludge reduced his fertilizer bill by about $30 per acre. He also saved about $20 per acre in tillage costs and $10 per acre in lime costs.

Hottel was on board. Now he puts all of his 1,600 acres in cover crops and uses sludge where he can on his corn-soybean rotation.

"I grow cover crops on as much land as I can every year," he says. "When you have something that works, you don't change. And, if you don't take care of your ground, it's not going to take care of you." —*Andy Clark*

Jones Creek whips through John Briscoe's cotton field like a garter snake. During a rainstorm, water moves in sheets down the sloping field toward the bank, taking Briscoe's soil with it.

"Every year, two or three new ditches washed out too deep to cross with a picker," recalls Briscoe, who raises cotton, soybeans, corn and beef cattle on a third-generation family farm in north Mississippi. "One year we had an absolute gulley washer that left a hole big enough to put a house in. We had to use a 'dozer to fill it in and put a levee around it."

In 1995, he had only two choices to comply with Mississippi's erosion control rules: He could build terraces or convert to no-till farming. He opted to build a terrace. While it did slow the wash of topsoil from below the terrace, a year later ditches began forming above the structure.

This time Briscoe had a third choice for conservation compliance: He could plant an inexpensive vegetative barrier above the terrace to slow water flow and trap sediment.

In part thanks to SARE research headed by Seth Dabney, vegetative barriers — or grass hedges — have been added to the Natural Resources Conservation Service Field Office Technical Guide for Mississippi as an approved erosion control practice. Grass hedges also are eligible for cost share through the Environmental Quality Incentives Program (EQIP).

An NRCS district conservationist recommended that Briscoe talk to Dabney about trying a hedge in his field. The researcher and the farmer walked the field together and reviewed the options.

Though he was skeptical about the effectiveness of a hedge, Briscoe opted to plant one rather than use more precious topsoil to build another terrace. It was a purely financial decision. At $6 a pound for switchgrass seed, Briscoe could sow a 10-foot hedge across his field for about $100. The terrace would have cost about $2 per foot, or $4,000 to cross the 50-acre field.

After evaluating the hedge for two seasons, Briscoe is convinced he made the right choice. A 10-

RESEARCHER SETH DABNEY GESTURES TOWARD A $100 GRASS HEDGE THAT CONTROLS EROSION; CONSTRUCTING A TERRACE COSTS $4,000. PHOTO BY GWEN ROLAND.

IN PART THANKS TO SARE RESEARCH, VEGETATIVE BARRIERS — OR GRASS HEDGES — HAVE BEEN ADDED TO THE NRCS' TECHNICAL GUIDE FOR MISSISSIPPI AS AN APPROVED EROSION CONTROL PRACTICE.

foot swath of blue-green switchgrass waves across the sloping cotton field like a Mohawk haircut. At ground level, the space between thousands of reed-like stems is clogged with soil trapped on its way to the creek. But most telling of all, no new gashes are splitting the hillside.

"Not only is it working, but it takes up less space than terracing," says Briscoe, sweeping his arm over rows of cotton blossoms jostling against the hedge. At 50 feet wide, the terrace takes up about two and a half acres of his field. At only 10 feet wide, the hedge takes up about one-fifth that space.

Mowing once or twice a season is the only maintenance required once the hedge is well established, says Dabney, who has been researching vegetative barriers for nearly a decade. "During the first season there may be washouts in the hedge at the points of highest water flow," he says.

Such washouts can be fixed in a few minutes with a shovel. A terrace, on the other hand, needs regular maintenance often requiring earth-moving equipment.

Although many plants may make up a hedge, the ideal hedge grassplant is cold hardy with thick, woody stems and dense, erect growth. Dabney's research shows that Alamo switchgrass has those characteristics, so that's what is specified in the Mississippi standards. Switchgrass also has the advantage of being a native plant that doesn't invade the cash crop.

"It's not invasive because it is kind of a slow starter," says Dabney. "Crabgrass and other annuals can choke it out if given a chance, but John established an effective barrier the first season. By the second season, it is solidly established."

Farmers should not assume vegetative barriers can replace terraces in all situations, Dabney cautions, since there are areas of concentrated water flow where vegetation couldn't withstand the force. "Hedges can slow down runoff waters and trap sediment," he says. "They may even enhance infiltration, but they will not completely intercept and cut off runoff waters. As field sizes increase, hedges reach a limit where other technology is needed to handle the accumulated runoff."

The official acceptance of vegetative barriers doesn't mean the research is over. Far from it, says Dabney. Among other things the research team is looking into the pest management characteristics of the hedges. An Arkansas researcher determined hedges attract big-eyed bugs and other beneficial insects.

"It may turn out that there are enough benefits to work hedges into an IPM program," Dabney says.

The search for better varieties of switchgrass continues. Project cooperator Joel Douglas of the Jamie Whitten NRCS Plant Materials Center has been breeding switchgrass from wild collections since 1993. He hopes to develop a shorter switchgrass that would require less mowing, saving farmers time and money.

Douglas' research plots have reduced a slope at the Whitten Center from 7-percent grade to 5-percent grade in just four growing seasons. "All we did was plant them and leave them alone," he says. "In addition to the soil buildup and leveling, we also have improved filtration when it rains."

Even though vegetative barriers have been used for thousands of years in other countries, Mississippi is the first U.S. jurisdiction to officially recognize their effectiveness. The inclusion of vegetative barriers in Mississippi's interim standards also marks the first time a SARE project has directly influenced state agricultural policy.

Dabney, who is based at the ARS National Sedimentation Lab at Oxford, is now working with a committee revising the National Interim Practice Standard for grass hedges.

As for Briscoe, seeing how the hedges hold soil in place is encouraging him to consider additional changes on the family farm.

"In my lifetime I've seen ditches get bigger. That may be the result of so much timber being cut in the area — or it could be from our farming practices."

Briscoe, whose neighbor no-tills 2,500 acres of cotton, now is considering incorporating the practice. "The savings in just labor is enough to make you take it seriously," he says. — *Gwen Roland*

In a 39,000-acre national wildlife refuge that borders the California-Oregon state line, agricultural and wildlife habitat protection interests have maintained an uneasy relationship since the 1960s.

In 1964, the Kuchel Act set up the Tulelake National Wildlife Refuge to help preserve one of the nation's premier nesting sites for waterfowl, with a twist: It mandated that "optimum consideration" be given to agricultural enterprises in the area. Since then, farmers have leased land in the refuge to grow potatoes, small grains, alfalfa, onions and sugar beets.

The farmers are following in the footsteps of their parents and grandparents, who migrated to the fertile valley in and around the present-day refuge in the late 1800s. But their farms bordering and within the Tulelake Refuge, while yielding about three times more per acre than in less fertile areas, are part of a stop on the Pacific flyway that attracts 1 million waterfowl each year.

While such competing interests usually come to a head, a compromise of sorts has worked in the Tulelake Refuge since the Kuchel Act. That act recognizes the incredible soil fertility and importance of agriculture to the local economy as well as the vital source of food farming provides to the waterfowl. The complementary relationship worked for years until scientists discovered the wetlands were declining.

As opposing forces debate the future of the Tulelake Refuge, a group of researchers, refuge staff and farmers have devised a system to rejuvenate the wetlands while perpetuating agriculture. A key player in that work, SARE-funded researcher Carol Shennan, has helped set up a system that rotates wetlands and farming to rejuvenate the marsh and offer prime soil to participating farmers.

"The wetlands are no longer good habitat for birds," says Shennan, an agroecologist at the University of California-Santa Cruz. Studies have shown agricultural runoff is a not a major factor in that decline. Most of the refuge, governed by an old flood control plan that ended the alternating ebb and flow of water that occurs in a natural wetlands system, is stagnant.

"We have a very mature unproductive marsh where few new plants germinate because of stabilized water depths, and there is little habitat diversity," Shennan says. "Under rotational management, we can use agriculture as a disturbance to break the cycle and restore young stages of marsh development."

The project creates rotational land uses — wetlands or farms — that switch every three years. Farmland is flooded to create wetlands of differing water levels, while unproductive wetlands are drained to create farmland on soil untouched by a plow for decades, at least. The system promises more diverse wetlands and fertile farm soil that needs few, if any, amendments.

The complicated system already has brought results. In just the second year, a former farm in active production for 40 years sprouted diverse flora, with tules, bullrushes and cattails growing just months after flooding.

"It's been really astounding," says Dave Mauser, a wildlife biologist at the refuge. "In little marshes we've created, we're getting wetland vegetation the first year out of farming. It's a quick transition, and the bird use has really followed suit."

For farmers who lease land in the refuge, the project

IN JUST THE SECOND YEAR AS WETLANDS, A FORMER FARM IN PRODUCTION FOR 40 YEARS SPROUTED DIVERSE FLORA JUST MONTHS AFTER FLOODING.

GEESE RETURN TO TULELAKE NATIONAL WILDLIFE REFUGE'S REJUVENATED WETLANDS NEXT TO FARMS THAT PROVIDE A VITAL WATERFOWL FOOD SOURCE. PHOTO BY CAROL SHENNAN.

offers an unparalleled opportunity to reduce their use of purchased fertilizers and pesticides. The virgin soil hosts few, if any, soil-borne pathogens like nematodes.

Sid Staunton, who grows potatoes, small grains and onions on 1,500 acres both adjacent to and on refuge-leased land, hopes to secure a lease on the converted wetlands. He anticipates a big savings in input costs such as nematacides, which can run $250 an acre.

"We'd have a disease-free soil that's really rich in nutrients, so we wouldn't need to put in huge inputs," says Staunton, who serves on Shennan's 10-member farm advisory committee. "It's a good way to use a natural system to clean up some of the soil-borne problems that build up over time."

Rotating the two land uses for the mutual benefit of farming and wildlife habitat perfectly meets the intent of the Kuchel Act, Mauser says. The legislation creating the farm lease program provided surplus ag crops for birds while keeping them from the high-value rice crop in California's Central Valley.

Farmers leasing refuge land are used to bird pilfering, Staunton says. Most of that occurs on grain stubble because the birds migrate in fall after harvest or in spring before planting.

Shennan also is working with farmers to increase their use of cover crops to provide habitat for nesting birds, reduce soil loss through wind erosion, suppress weeds and improve soil organic matter. It's especially challenging in the basin because of a 4,200-feet elevation that can bring severe frosts year round.

The project also establishes the long-term transition of farmland into what Shennan hopes will become a productive, mature marsh. Using computer modeling, she will study different rotation scenarios on a refuge-wide scale.

"We want to set up a framework to judge impacts of each potential rotation design on water quality, habitat diversity and economics," she says. "It involves looking at the system from multiple perspectives so we can use it as a tool with farmers, environmental groups, hunting groups and refuge managers to quantify benefits and tradeoffs. There's a tremendous amount at stake."

Some farmers remain skeptical about the future of farming in the Tulelake Refuge. Staunton, on the other hand, is optimistic the new system will lower costs for farmers while improving wetland and wildlife values.

"It's a real on-the-ground solution, and, for the amount of money invested, the dividends are incredible," he says. "This thing could solve this area's resource conflicts quickly, and we can continue to have good food value from this area." — *Valerie Berton*

As beef prices spiraled downward like a Kansas twister throughout the 1980s and early 1990s, ranchers in the Great Plains began selling their spreads to agricultural corporations and housing developers. Watching some of the best grassland in the world be subdivided for second homes, a group of Kansas ranchers decided to take action.

CO-OP MEMBERS HOPE THE EXTRA PROFIT WILL HELP PRESERVE A WAY OF LIFE THEY SEE RAPIDLY DISAPPEARING ON THE PRAIRIE.

Thus was born the Tallgrass Prairie Producers Co-op, ranchers who figured a collective strategy had a better chance of weathering the storm.

"Ranchers are very independent—we're not used to working together," says Annie Wilson, a co-founder of the Kansas beef cooperative and its fledgling effort to obtain better prices for sustainably raised beef. But when struggling ranchers heard about preliminary meetings of the group, "They kept showing up."

Today, Tallgrass Prairie Producers Co-op consists of nine ranching families throughout the state who produce beef on grass and market it accordingly. They are banking on the willingness of consumers to pay for beef raised on a protein-rich grass that has been the envy of other ranchers for generations. Until the 1940s, in fact, Texas ranchers used to truck their cattle north to finish them on Kansas grass.

Aided by a SARE grant, the co-op worked with the Kansas Rural Center to hire staff to create labels, coordinate production and, above all, market beef. They now sell beef to a hospital, restaurants, small groceries and directly to individuals. At the 'Buy Kansas' Expo 1997, Tallgrass Beef was voted best Kansas product.

"It's a great effort by people trying to live by their principles and have their product reflect that," says Dan Nagengast of the Kansas Rural Center. "There's a big striving in this country for 'real' things. Pepperidge Farms will never be a farm, but here's a product that is what they say it is."

Most U.S. beef comes from cattle finished in feedlots, where they eat large amounts of grain. By finishing beef on pasture, co-op members cut out the extra, energy-intensive process of planting, harvesting and shipping grain. Instead, their production model keeps land in grass, conserving soil and water quality. Their animals are raised without hormone implants or antibiotics.

The resulting leaner cut of beef has yielded impressive nutritional test results, and, Tallgrass Beef producers boast, tastes better. An average cut of Tallgrass beef breaks down to 116 calories, 1.5 grams of fat and 0.7 grams of saturated fat. Co-op members feel sure once that information gets out, their product will bring a better price in the marketplace than conventionally raised beef.

"We're trying to break out of the corporate-industrial mold," says Pete Ferrell, a local rancher and the co-op's secretary-treasurer. "We want to capture the value of what we're doing, to be price-makers rather than price-takers" in the fluctuating beef market.

The key, they say, is spreading the word, finding the niches where they can sell their different brand of beef. They attend conferences, workshops and trade shows, land stories in the local press, write for newsletters and talk up their product to whoever will hear them.

Their first customer was a local hospital, where the staff dietician was wowed by the lower fat content of co-op beef. A restaurant in Wichita specializing in low-fat food soon followed.

More recently, the co-op landed its first out-of-state customer. A Baltimore trade

show brought co-op representatives in contact with a Hudson Valley, N.Y., distributor that supplies food clubs and natural food stores in New York, Connecticut, Pennsylvania and New Jersey.

"They called us as soon as we got home and said they were ready to go," says Wilson, the co-op's business manager. The co-op began shipping frozen beef from Kansas in late 1997.

The effort was not without tough initial challenges. A severe drought plagued Kansas just as the co-op got underway, and cutting through what seemed like yards of bureaucratic red tape to establish a logo, business plan and marketing strategy tried their patience.

Yet, co-op members are heartened by the potential of Tallgrass Prairie Producers to reach consumers all over the country. They hope the extra profit will help preserve a way of life they see rapidly disappearing on the prairie.

"Though our community life may be fulfilling and supportive, it belies the underlying economic crisis in this area, where young ranchers are rare as thunderstorms in winter." Wilson wrote for *The Land Report*, a Land Institute publication, in 1995. "The best that most young people wanting to stay on the land can hope for is to find a job as a manager or hand for one of the absentee 'mega-ranchers.' I grieve for their loss of a personal, long-term stake in the land — the bonding and commitment that comes from knowing the hills and grasses they manage are truly their home[s] and must be preserved for their children." — *Valerie Berton*

RANCHER AND CO-OP BUSINESS MANAGER ANNIE WILSON TELLS PEOPLE SHE RAISES "HEALTHY ANIMALS ON HEALTHY LAND." PHOTO BY VADA SNIDER.

Like farmers' markets, community-supported agriculture (CSA) farms continue to multiply as consumers seek local alternatives for fresh food raised without excessive use of agri-chemicals. Observers estimate close to 650 CSA farms operate throughout the United States, with the largest concentration in the Northeast.

The growth of CSA, with its huge diversity of farms and farm offerings, makes it difficult to characterize and determine the success of what some dub a new movement in agriculture. To determine whether CSA farms in the Northeast are economically sustainable and to gain and distribute knowledge about CSA, a group of SARE-funded researchers in Massachusetts and New York are trying to reach the approximately 250 CSA farmers in the region through surveys, peer mentoring sessions, a region-wide CSA conference and an annual CSA directory.

The typical CSA farm offers pre-paying customers a quantity of fresh produce weekly throughout the growing season. Growers gain by having a guaranteed market for their products; consumers enjoy fresh, usually organically raised, and often unusual produce, as well as the knowledge that they are supporting the viability of a particular farm in the community. Often, consumers volunteer on the farm or participate in CSA farm events.

"There is really not much available on the economics of CSA, so we wanted to acquire data characterizing an average CSA [farm], its issues, and its costs and returns," says Dan Lass, a University of Massachusetts economist who coordinates the SARE project. "This is the beginning in a quest to build our stock of knowledge on CSA [farms]."

Lass accumulated information on CSA share prices, CSA expenses and CSA income. He found the average price of a CSA share to be about $460 in 1996, based on a full share equalling about 400 pounds of produce for the season.

With Jack Cooley, then pursuing a master's degree in nutrition at the university, Lass calculated retail values for several CSA shares.

COMMUNITY-SUPPORTED AGRICULTURE PROVIDES FARMERS WITH A MARKET THAT DOESN'T SEND BACK A LESS-THAN-PERFECTLY-ROUND TOMATO. PHOTO BY JERRY DEWITT.

WHILE THE AVERAGE PRICE OF A COMMUNITY-SUPPORTED AGRICULTURE (CSA) SHARE WAS ABOUT $460, CONSUMERS BUYING AN EQUIVALENT AMOUNT OF ORGANIC PRODUCE IN A STORE COULD EXPECT TO PAY $1,000.

Based on their findings, consumers buying an equivalent amount of organic produce in a store could expect to pay $1,000. If they bought conventionally raised produce in a supermarket, they would pay between $680 and $780, translating to a $200 to $540 savings for CSA members.

While that may be good news for CSA members, who usually have to shell out a few hundred dollars in the spring for their farm shares, Lass says low member prices may come at the expense of the farmers. He found few cases where farmers specified a salary for themselves. Most planned to pay themselves from income remaining after reckoning the season's bills.

However, many of those farms had little left over to pay the operator any wage.

The farmers calculate what it costs to produce the food, then set share costs accordingly. "An important part of that cost should be a wage for the operator," Lass says. "Because some farmers are not paying themselves enough wage, they really are losing money. It's unlikely these CSA operations can exist very long without paying the operator a fair wage."

He suggests that, on average, CSA owners adjust the prices they charge up to about $120 more per share per season. The substantial savings over store prices can absorb—and, in fact warrants—such an increase, Lass says.

"While CSA owners seem nervous about paying themselves a fair wage, they deserve it," he says. "It's important for long-term viability."

Those savings do not consider the many other benefits of CSA not included in shareholder prices, such as the environmental pluses from produce raised without agrichemicals and the community rewards from involving a group of consumers in a local farm operation. Most CSA farmers offer an educational experience of sorts for their members by hosting them at events at key times during the season or encouraging them to volunteer in planting, harvesting or distributing shares.

"People who join CSAs are not just buying produce, they're supporting agriculture," Lass says. "You're voting with your money to support a particular farm, and you need to be willing to pay to include other benefits, not just the value of the produce. The monetary benefits of less-expensive produce is just gravy on the reasons you've joined."

CSA farmers harbor strong feelings about their impact on natural resources and their responsibility to their communities. Farmers seek to create environments where beneficial insects thrive. They build their soils with cover crops and organic matter. And they thrive on their relationships with CSA members whose goals for fresh, sustainably produced food mirror their own.

CSA also provides farmers with a market for their produce that doesn't send back a less-than-perfectly-round tomato or pay them widely varying prices from season to season. The mutual benefits have made CSA a true partnership between food producers and consumers.

"One hundred years ago, the majority of people in our society were directly connected to agriculture," says Steve Gilman, in one of the annual CSA Farm Network publications he has produced as a cooperator on the SARE project. "While the ties have been liberated, the connections to the land, to community, to producing one's food, to a supportive and caring culture, are prominent needs. CSA originated where people strongly value their connections to local farms and food."

Gilman's Farm Network directory lists CSAs throughout the Northeast, as well as information about CSA decision-making structures and inspirational essays from farmers. The publication is just one of the project's outreach tools; the CSA regional conference drew 320 participants in November 1997—with more than 200 turned away.

The conference, which featured CSA farmers from each Northeast state, received "incredible feedback" in participant evaluations, says Elizabeth Keen, acting director of CSA North America, conference organizer and another coordinator in the SARE project. "The idea was to bring in both experienced and non-experienced folks to talk about production practices, the core specifics of growing and the CSA as a working entity in addition to just farm work."

—*Valerie Berton*

Back when Harry's first opened in 1987, there would be a line of pickup trucks loaded down and waiting for us every morning," recalls Dana Peters, produce buyer for Harry's Farmers Market of Atlanta. Perhaps it was no surprise that Harry's would grow to become a chain of four super stores where city customers now buy premium quality Georgia produce and other specialty items, from stoneground grits to muscadine jelly.

THE FARMERS RECEIVE A PREMIUM PRICE FOR THEIR CROPS, WHILE CUSTOMERS GET FRESHER FOOD FREE OF THE POST-HARVEST CHEMICALS OFTEN USED TO RETARD DECAY ON LONG DELIVERIES.

Ironically, as Harry's was whetting Atlanta appetites for fresh local products, farmers all over the state were washing the red dirt from their hands for the last time.

"So many small farms have gone out of business since then, it's a challenge to find enough to supply us," says Peters. "What's so frustrating is that we have good farmers out there who know how to grow vegetables. I've never understood why buyers go to Mexico for produce when we have farmers who can grow it in our back yards."

While Peters was looking for farmers, a group of south Georgia farmers desperately sought a market. The African-American family farmers in Brooks, Thomas, Grady and Decatur counties have been stewards of the land for generations—they know how to grow the finest southern peas, beans, watermelons and greens.

Getting a decent price for such regional staples was another matter. At the only farm auction in the area, a handful of large brokers bid on all the produce. When a farm community shows up at auction with snap beans harvesting 300 to 400 bushels per acre, they have no leverage for negotiation. In fact, the more they grow, the less their crops bring at market.

To improve their returns, a group of farmers established the South Georgia Vegetable Producers Cooperative. "Working alone, we farmers practically have to give away our crops to wholesalers," says co-op President Jones O. Thomas, who farms the 500 acres where he grew up. "But by getting together in a co-op to make big shipments, we have more bargaining power."

The co-op, however, did not solve their problems. Grocery chains like Publix and Krogers wanted all vegetables to conform to a particular size, which was too difficult to coordinate.

It was obvious their grassroots effort needed help. In 1995, The Federation of Southern Cooperatives assisted them in reactivating the South Georgia Vegetable Producers Cooperative. Another partner came in the form of the Southeast Regional Alternative Agriculture Project (SERAAP), a multi-institutional initiative that links farm communities, agribusinesses, research institutions and service agencies to promote sustainable farming systems. Finally, the Federation of Southern Cooperatives and The University of Georgia (two SERAAP collaborators) teamed with Harry's Farmers Market and The South Georgia Vegetable Producers Cooperative to propose a SARE project to design a production and marketing system for limited-resource farmers.

The collaborators designed a rapid post-harvest grading and packing system that allows the South Georgia Vegetable Producers Co-

THE SOUTH GEORGIA FARMERS' CO-OP HARVESTS AND DELIVERS PRODUCE WITHIN 24 HOURS TO A POPULAR ATLANTA MARKET. PHOTO BY FREDDIE PAYTON.

operative to deliver a truckload of high quality, field-graded vegetables to Harry's in Atlanta within 24 hours of harvest. The schedule calls for harvesting and grading by day, then trucking overnight to travel the seven hours to Atlanta and stock Harry's shelves within 24 hours of picking.

The farmers receive a premium price for their crops, while Harry's customers get fresher food free of the post-harvest chemicals often used to retard decay on long deliveries. The short transport also saves thousands of gallons of fossil fuel each year.

As part of the market-driven system, the farmers are learning to stagger their plantings and to raise more kinds of vegetables instead of the three or four staples they have grown for generations. Dana Peters tells them which crops bring top dollar and tend to be in short supply, such as radishes, beets, green onions and carrots. In coming seasons, they may diversify by growing exotic eggplant, white sweet potatoes, red sugar cane, guava beans, napa cabbage and bok choy.

"Georgia has climate and soil similar to California," says Peters. "Much of what is shipped across the continent could be grown right here. It doesn't make sense to haul those foods 2,000 miles at tremendous cost to our air quality."

Pete Spencer was one of the first farmers to plant the non-traditional crops. On a golden October day, three co-op members visit to check out his green onions, radishes and carrot seedlings peeking out of the soil. There's some rib-punching and snorting about "sissy" crops until Peters points out that not only are they high-value crops, but the $3-per-box savings in shipping costs equals more profit that can be passed along to the farmers. The teasing changes to serious talk about scheduling their own plantings of carrots and radishes.

Diversifying crops, staggering harvests and coordinating packing and transportation is only a starting point for the farmers. They also are learning marketing savvy, such as the importance of a distinctive label for co-op products and the necessity to provide steady shipments year round. Mastering sustainable production practices will help cut costs and build soil health.

"In this project, everyone learns together," says Freddie Payton, an assistant professor at the Institute of Community and Area Development at the University of Georgia and the project leader. "We are encouraging other researchers and service personnel from the public and private sector to partner with farmers and retailers in developing and evaluating systems. When all stakeholders have a voice, there's more assurance that the product or process developed will serve the needs of everyone involved." — *Gwen Roland*

Even in potato-proud Idaho, it can be hard to find fresh, locally grown vegetables, especially organic ones. Grocery stores in metropolitan Boise carry them, of course, and some of that produce may have come from the region's rich, volcanic soil.

But, often, shoppers buy Idaho-raised vegetables that have made a detour to produce brokers in California before being shipped back home.

That irony was not lost on Janie Burns of Nampa. Ten years ago, Burns decided to grow vegetables as a sideline to her work as a sheriff's dispatcher. "I felt I could offer a better product than what was in the supermarket, something people would buy," she says.

"I FELT I COULD OFFER A BETTER PRODUCT THAN WHAT WAS IN THE SUPERMARKET, SOMETHING PEOPLE WOULD BUY."
— JANIE BURNS

Though she was a longtime buyer of organic produce and advocate of sustainable agriculture, Burns had no prior experience but lots of enthusiasm. In the first year, she says she planted "everything I liked" — lettuce, carrots, beets, broccoli and onions.

She soon found a strong demand for local, sustainably and organically grown produce that exceeded what her quarter-acre market garden could supply. She squeezed in extra shifts in her garden before cutting back to part-time hours on her day job. After four years, the "sideline" became her full-time job.

She struggled to offer enough variety, build repeat business and keep up with deliveries and billing. "I started small, and it got out of control," she says.

Burns and other growers in the Treasure and Magic valleys outside Boise started talking about teaming up. A SARE producer grant offered them a trial year to find out whether a growers' cooperative that would market their produce to area restaurants, caterers and natural foods stores was the answer.

The growers hoped a cooperative approach would be more efficient and profitable, while offering their community access to fresh, sustainably grown vegetables.

"The grant allowed us to run for a year without worrying about overhead or legal issues," says Paul Sharratt, co-op president.

Working with the Northwest Coalition for Alternatives to Pesticides and advisers from the U.S. Department of Agriculture, the Idaho growers initially surveyed potential markets, from restaurants to grocers. Results supported Burns' belief that a co-op could find a niche selling high-quality, sustainably grown produce. From a group of 10 to 15 growers, six committed to the idea and sought organic certification from the state.

While some growers work garden-sized plots, others have hundreds of acres. Despite the variability in size, all of the growers wanted to lay the groundwork for what was for most, a sideline enterprise. "Most of us have day jobs," says Sharratt, an engineer.

With technical assistance from the Rural Business and Cooperative Development Service in Washington state, the group pulled together the paperwork to become a nonprofit corporation: Idaho Organics Cooperative Inc.

In 1997, the co-op did about $10,000 worth of business, Burns says. Customers included a health food store, a caterer and restaurants of various sizes and price ranges. In all, about a dozen clients bought from the co-op, with five placing consistent orders.

"We're appealing because we offer a variety of products with one contact, one order and one billing," she says.

For participating growers, the co-op opened up more profitable alternatives to sell-

A RESTAURANT CHEF WHO RECEIVES FRESH VEGETABLES FROM A NEW IDAHO GROWERS' COOPERATIVE SAYS, "THIS IS WHAT PRODUCE IS SUPPOSED TO LOOK LIKE." PHOTO BY T. L. GETTINGS/RODALE IMAGES.

ing at farmers markets. Working together allowed them to share the workload and offer a greater variety of products.

With Idaho's short growing season, growers really hustle through the summer. The co-op starts selling around late April, with the peak of business occurring between June and mid-October. In the future, some of the larger producers hope to offer storage crops through mid-February.

Last summer, the co-op's "fresh sheet" listed three pages of produce for sale, including tomatoes, lettuces, peppers, watermelons, cantaloupes, herbs and flowers. The co-op also offers staples such as potatoes, onions, squash and dry beans.

Orders are delivered within hours—not weeks—of picking. Usually it's Burns, who lives farthest from Boise, who loads her small pickup and makes the deliveries for Treasure Valley growers.

She says she knew the co-op would succeed one morning when she was dropping off an order at an upscale Boise restaurant. "As the chef was unpacking the box, he called each one of his assistants over and told them, 'This is what produce is supposed to look like.'"

Customers praise the produce's freshness and shelf life. Unfortunately for the co-op, some buyers place smaller orders because they have less spoilage and wasted produce than vegetables and fruit trucked long distances.

If clients want custom-grown produce, the co-op delivers. One chef wanted his food to literally stand tall at his restaurant. "He likes vertical or 'tall' food," Burns explains. "He's into art."

For his plate sculptures, the chef wanted chives that wouldn't go limp when they were stabbed and artfully curled over garlic ginger mashed potatoes under a slender sliver of arching carrot. The co-op's main herb growers obliged by letting their chives grow longer and stronger.

In 1998, the co-op is making expansion plans, having reached the limit of once-weekly pickup deliveries. The group is considering more members, along with expanded volume and variety to meet the growing demand from the community.

Burns sees encouraging national trends for ventures like the co-op: an aging, health-conscious population, a growing interest in organic foods and increased spending on food away from home. The only barrier to doing more business, she says, is the investment needed to develop and open more markets.

"To move growers into organic production," she says, "there has to be a market they can access at the other end." —*D'Lyn Ford*

In an old section of downtown Omaha, Neb., gardeners wanting to improve their community and beautify the neighborhood took volunteers and planned a garden. After cleaning the weeds, trash and broken glass from a half-corner lot known for drug deals, the group began an outdoor learning center of sorts while permanently changing the character of the area.

To finance the venture, the new community group, City Sprouts, turned to a Nebraska small grants program. Called IMPACT, the statewide program has funded 31 groups primarily made up of farmers to foster learning about sustainable agriculture. IMPACT, run by Nebraska's Center for Rural Affairs, received a 1995 SARE grant to create supportive educational environments where participants learn about sustainable farming techniques based on peer approval and local needs.

Those projects range from City Sprouts to a group of crop producers demonstrating legume cover crops, from vegetable producers seeking to set up an organic certifying chapter to livestock producers attempting to gain a premium price for their meat by forming a marketing cooperative.

What all of the groups have in common, however, is that they initiate and undertake projects that have meaning to them, says IMPACT coordinator Wyatt Fraas.

"The diversity of ideas far exceeds our imaginations," he says. "The fact that they feel project ownership practically ensures successful results because the participants are really interested in their projects."

The City Sprouts project evolved into much more than a garden plot for local residents to grow lettuce and tomatoes. After buying the property, cleaning out the weeds and trash, and amending the soil, the group began teaching interested residents, many of whom had difficulty finding fresh vegetables in their inner-city neighborhood, how to grow produce. Perhaps more important, the residents also learned how to sell what they grew at a city farmers market.

"It used to be a space where people hung out, drank and got violent," says Andrew Jameton, a City Sprouts leader. Concerned about quality of life in the neighborhood, and to fill a void in small-business education and economic development, the group created a program for urban denizens to learn a new trade. They hope residents can learn enough to count on a regular part-time income from their garden work.

"It wasn't just for garden volunteers to get vegetables," Jameton says. "We wanted to teach them about running a small business."

In the first year, the garden grossed $1,000 at the farmers market. Garden volunteers receive regular food bags as payment in addition to their education, and City Sprouts offered free vegetables to city residents, who seemed thrilled to have access to quality collard greens, salad greens, kale, tomatoes, potatoes, beans, greens and herbs.

The garden also functions as a community gathering place. Thus far free of vandalism or theft, the garden draws

A SURVEY OF PARTICIPANTS FOUND THAT 30 PERCENT REPORTED IMPROVED PROFITABILITY AND 40 PERCENT SAW DECREASED SOIL EROSION.

A VISITOR TO THE LANGE FARM IN FORDYCE, NEB., TRIES TO ENTICE AN ANGORA GOAT WITH SOME LEAFY SPURGE, A NOXIOUS WEED SOME ARE TRYING TO CONTROL WITH GOATS RATHER THAN HERBICIDES. PHOTO COURTESY OF THE CENTER FOR RURAL AFFAIRS.

visitors to its small memorial and a peace pole built to commemorate the violent deaths of neighbors in recent years. City Sprouts hopes to expand the success of its first garden throughout the inner city.

"When lots become vacant, the wonderful stand of old houses in downtown Omaha deteriorate with them," Jameton says. "Vacant lots are dangerous as well as ugly. If we can encourage people to garden in inner-city Omaha, we can help not only them, but the neighborhood as well."

Fraas views City Sprouts as a model of what IMPACT is trying to accomplish with small grants in Nebraska. IMPACT was created to advance sustainable agriculture — including farm profitability, protection of natural resources and community support — by showing farmers and community activists they were not alone in their goals.

In 1996 and 1997, IMPACT funded more than 130 group members on about 80,000 acres of farm and ranch land.

"One way of supporting farmers is to get groups together to support each other," Fraas says. "Farmers often say they feel alone" when they try more sustainable farming practices. "Often there is pressure from the community to not do what they're doing. One way to overcome that is for groups of farmers to work together."

The group process often results in a wider acceptance of sustainable practices, Fraas says. That dynamic counters the skepticism with which farmers and ranchers may greet new ideas.

An IMPACT survey of its group participants found more than half have tried a new, more sustainable practice on their farms. Thirty percent reported improved profitability, 40 percent saw decreased soil erosion, 60 percent increased diversity of commodities grown, and 50 percent reported improved wildlife habitat.

Many IMPACT groups work with Extension educators who not only teach about new practices but also expand the knowledge base among their colleagues. An Extension dairy specialist who worked with one group credits IMPACT with turning him on to the various benefits of management-intensive grazing. He went on to organize the state's first conference on the subject.

Farmers remain the best sources of information for other farmers. The IMPACT-supported Hoofmasters group, a handful of new graziers, holds farm tours that have drawn a number of interested farmers. Ken Kruse, the only Hoofmaster participant who switched to a seasonal milking system — which takes advantage of the cost savings and lifestyle benefits of drying off cows each winter — says the group provides needed support as he takes off into unchartered waters.

"I got into rotational grazing in 1995, when the group started," says Kruse, who raises 60 Holsteins and a few dozen replacement heifers. "The rest of the guys in the group are all doing the same thing, so we talk back and forth, work problems out together and get new ideas." — *Valerie Berton*

RESEARCH FROM AROUND THE COUNTRY SUGGESTS THAT COMMUNITY, SMALL-SCALE PROCESSING OPERATIONS CREATE RURAL JOBS AND HELP KEEP MONEY CIRCULATING IN THEIR COMMUNITIES.

Walk into Side Hill Acres barn, and it's clear Rita Kellogg's 140-plus dairy goats adore her as much as she enjoys them. Goats crowding in around her, Kellogg rattles off the names, ages and personality traits of several individual animals.

Step into Kellogg's small, four-year-old cheese processing plant and her pride in the Candor, N.Y. facility—and the delectable array of cheeses the family-run operation produces—is equally obvious.

The Kelloggs launched their cheese-making business after the processor to which they'd been shipping 8,000 pounds of milk per week went belly up. If the family wanted to continue goat farming, there wasn't much choice but to take processing in-house.

Startup wasn't easy, but the on-farm processing operation has proved successful. Side Hill Acres now sells about 360 pounds of handmade cheese per week to restaurants and supermarkets in the Finger Lakes, Syracuse and Western New York area. The farm produces a lot less milk than it did four years ago, but makes more money.

"We're doing much better being our own processor," Kellogg says.

Kellogg has been an active participant in a SARE-supported project focusing on commercial small-scale food processing as a way to enhance farm income, rural employment and quality of life. As a farmer-processor member of the project's advisory board, she's helped guide the project so it meets producers' needs.

Coordinated jointly by the Cornell University Farming Alternatives Program and the New York Sustainable Agriculture Working Group (NYSAWG), the project focused on both technical and public policy issues crucial to small-scale food processors. Participants aim to help sustain small and medium-sized farms in the Northeast by building market opportunities.

"We're trying to foster a growing industry which can help farmers revitalize their farms and rural communities," says NYSAWG's Alison Clarke.

Given the region's climate, topography, soils and proximity to urban population centers, competing in the global raw commodity market simply may not be economically viable for many of the region's farms.

"In this century, farmers have lost an enormous share of the consumer food dollar," says Duncan Hilchey of Cornell's Farming Alternatives Program. "We've gone from farmers receiving about 46 percent of the food consumer dollar to about 19 percent today. Some people think an even smaller percentage goes to the farmer."

The Cornell/NYSAWG project was designed to reverse that trend.

Small-scale processing, particularly on-farm, enables farmers to capture more of the consumer food dollar. Research from around the country suggests that whether they are located on farms or elsewhere in the community, small-scale processing operations also create rural jobs and help keep money circulating in their communities.

"The more we looked at these issues, the more we felt we needed to do something to help farmers market their products more effectively," says Cornell's Gilbert Gillespie.

Project organizers began by collecting and analyzing information about the status of small-scale food processing in New York. Through a survey of 600 of the state's small-scale food processors, participants learned much about the opportunities for and challenges to small-scale food processing.

Based on preliminary, anecdotal information, Gillespie and Hilchey suspected that regulation, particularly associated with food safety,

was a significant burden. They were wrong.

"We have a much better understanding of what the barriers really are," Gillespie says, explaining that they found far fewer obstacles in the food safety inspection arena than anticipated. "Ag & Markets inspectors are not necessarily the bad guys. In some cases, they can be phenomenally helpful."

The more significant challenges to small-scale processors, says Hilchey, are the more ordinary issues all small businesses share.

"It's just the cost of doing business: marketing, especially advertising; the cost of having employees; paying taxes; buying insurance," Hilchey explains.

Following the survey, the project organized a major conference offering roundtable discussions about those issues. The conference drew strong interest.

"The phone was ringing off the wall with potential and established processors wanting to register," says NY-SAWG's Clarke. Regulators, inspectors and economic and community development specialists also attended. Of the more than 230 people present at the conference, 95 percent voted to continue working together. Twenty-seven of them volunteered to explore the possibility of a small-scale processors' organization

In 1998, nearing completion of the three-year effort, the formation of a statewide food processors' organization is well on its way. Strong regional chapters will promote networking and cooperation among processors. Three chapters have officially formed; six others are in the works.

The chapters will provide educational services to members about start-up, food technology and food safety issues. Chapters also plan to build the marketing infrastructure to promote their region. Initial steps include developing logos and labels that will help to promote a regional identity.

Other plans include: developing a mentoring program through which an experienced processor would assist a start-up company; investigating possible ways to negotiate group insurance rates; providing assistance to comply with state and local regulations; and cooperative purchasing of basic processing supplies.

Organizers say the project has developed far beyond their expectations.

"We had anticipated a simple state-wide organization that would promote the interests of small-scale producers in Albany and publish a newsletter," Gillespie says. "We had not imagined local chapters promoting collaborative marketing efforts, a mentoring program and all of the other initiatives."

Getting formerly isolated individual producer-processors together has supported their growth, and bringing inspectors and processors together has promoted mutual understanding.

"I think the project is going to have some very positive and long-lasting effects," Hilchey says.

—Beth Holtzman

FARMERS AND OTHERS IN THE NORTHEAST ARE SHOWING AN EXTRAORDINARY INTEREST IN BRINGING FOOD PROCESSING—SUCH AS CANNING AGRICULTURAL PRODUCTS—IN-HOUSE TO ADD VALUE TO THEIR BUSINESSES. USDA PHOTO.

In the 1970s, Virginia Beach was a quiet farming community that happened to front on a scenic stretch of ocean. Ten years later, it was booming as a beachfront playground that catered to tourists from all over the mid-Atlantic.

Like so many agricultural communities turned commercial, little of the farming life survives in Virginia Beach. Today, Virginia Beach tourists dine on fruit and vegetables trucked in from other areas, and the local community long ago lost its small-town feel.

Observers across the Chesapeake Bay want their community to avoid Virginia Beach's evolution at all costs. In Northampton County, Va., a coalition of conservationists, farmers, business people and government representatives formed to preserve the character of their community. The county runs down the skinny peninsula between the bay and the Atlantic Ocean that constitutes Virginia's Eastern Shore. The coalition's main strategy: to add value to agriculture.

"We've started to look at sustainable development as a real possible future for the community, and sustainable agriculture is a logical link," says Terry Thompson, director of research for The Nature Conservancy (TNC), who leads a SARE project that seeks to improve community through enhancing agriculture. "We want to preserve the environment, the economy and a viable rural quality of life, realizing many here have a low quality of life."

Thompson works with researchers from Virginia Tech, Virginia State University and Old Dominion University, as well as the state Department of Agriculture, Extension and business contacts on the Eastern Shore to improve profits for about a

NORTHAMPTON COUNTY, VA., GROWER PHYLLIS SMITH HOPES HER VENTURE INTO THE DRIED FLOWER MARKET WILL PAY OFF. PHOTO BY CURTIS BADGER.

A BEEF PRODUCER WHO BEGAN GROWING SEEDLESS ORGANIC WATERMELONS EARNED 16 CENTS A POUND, A SIGNIFICANT INCREASE OVER THE 5 CENTS A POUND CONVENTIONAL VARIETIES NORMALLY BRING.

dozen farmers in Northampton County. The projects range from marketing a special variety of sweet potato to gaining a premium for organic, seedless watermelons.

Thompson and her group are banking on the spinoff effect of better marketing Eastern Shore products to raise the level of community awareness about the importance of agriculture—sustainable agriculture in particular. Each enterprise includes plans to minimize impacts on the Shore's fragile ecosystem.

"This is a great place to grow a lot of vegetables, but diversity and marketing are the big barriers," Thompson says.

The Hayman sweet potato, a historic Eastern Shore staple that packs a powerful flavor, fell out of favor with growers because of low yields. Its white, almost greenish flesh and a variable size and shape made the Hayman tough to move in the marketplace, despite what locals swear is an uncommonly good taste. Its soil and climate make the Eastern Shore one of the few places the Hayman thrives.

Vegetable farmer Butch Nottingham grows Hayman potatoes as a hobby crop, an indulgence on a small section of his 600-acre operation. With the help of SARE, TNC and a TNC-backed local business development corporation, Nottingham has embarked on an aggressive marketing campaign to promote Hayman potatoes as a premium product. With the Hayman, Nottingham finds himself in the rare position of growing a product he can't keep stocked.

"Now the Hayman has become more popular, it's easier to sell than to grow," says Nottingham, whose phone rings steadily with would-be Hayman customers. "I'm hoping to sell the small quantity I have for more money, making the experience of eating part of the price of the product."

Associating a popular product such as the Hayman with Northampton County could create an increased demand for local growers to fill not only in the mid-Atlantic region, but all over the nation. If his extra effort succeeds, Nottingham plans to sell seed potatoes to other county growers so they too can increase profits.

"The SARE project gives us an opportunity to go into a different direction, to find out if the product and the technology will come together and actually turn the Hayman into a business rather than a hobby," says Nottingham, who plans to market the Hayman on the World Wide Web for mail order sales.

The SARE project may answer the same question for Phyllis Smith, a Northampton County farmworker who has gained years of horticultural experience working at a local nursery. Aided by researchers from the University of Virginia and the Eastern Shore Research and Extension Center, Smith grew a large plot of ornamentals to sell as dried cut flowers. She hopes to sell them to artisans in the community who currently buy their craft supplies out of the region. In fall 1997, she sold more than half of her flower yield at one local craft demo.

"It's the first time I've done something like this," says Smith, a soft-spoken woman whose green thumb and deceptively strong back supports her family. "I really liked doing it compared to my usual work."

Smith's straw flowers, artemesium and globe amaranth grow in eye-popping colors. In fall, dried, they lose little of their luster. Thompson, TNC's representative, hopes business planning assistance may help Smith start her own part-time business to provide a model for other farm laborers who earn low wages.

A beef producer got the impetus from the SARE project to begin growing seedless watermelons for extra profit. Greg Turner certified his plot as organic, then grew a seedless variety of watermelons.

"I wanted to try something different without a lot of overhead," Turner says. His successful season brought him 16 cents a pound, a significant increase over the 5 cents a pound conventional varieties normally bring.

Turner's growing methods coincide with a deeply rooted belief that farmers should work in harmony with natural resources. His watermelon patch is a stone's throw from a creek that empties into estuarine waters, so he eliminated herbicides he once used to control the Johnson grass that plagues many coastal farmers.

"My land is surrounded by marsh, and I want my son to enjoy things as I had them as a kid," he says. "Many of those resources are not there anymore." — *Valerie Berton*

The people of northern New Mexico remain deeply linked to the dramatic landscapes and histories of their lands. Amid the Sangre de Cristo mountain range and in the path of the Rio Grande lie communities with firm ties to the cultures of ancient Native Americans and 16th-century Spanish settlers, both of which highly value agriculture.

Even so, the influences of modern life and competing economic development now greatly challenge the health of the rural area. The pull of such boom-or-bust industries as mining and tourism lured a generation of people away from their land and agrarian way of life. As in other areas, the newer industries have proven to be less stable and lucrative for many local inhabitants.

Now, with the help of a strong partnership of northern New Mexico producers, community development leaders and agricultural professionals, a promising mix of small-scale farming and value-added enterprises is emerging and reconnecting the community to its agricultural resources.

"This year we expect to bring in $100,000 of agricultural income to this part of New Mexico, where there was essentially none a year ago," says Craig Mapel, a marketing specialist from the New Mexico Department

AT THE TAOS COUNTY ECONOMIC DEVELOPMENT CENTER'S NEW COMMERCIAL KITCHEN, LESLIE PEDLAR WHIPS UP SOME DESSERT "DELIGHTS" FOR SALE AT LOCAL VENUES. PHOTO BY JEFF CAVEN.

A TEAM FROM NEW MEXICO IS LEVERAGING SARE FUNDS TO MAKE A SIGNIFICANT CHANGE IN THE QUALITY OF RURAL LIFE FOR HISPANICS, NATIVE PUEBLO INDIANS AND OTHER FAMILIES ON LIMITED INCOMES.

of Agriculture, NMDA.

Mapel leads a SARE-funded project to revive agricultural production in the region. He and a team from New Mexico State University Extension and the Taos County Economic Development Center are leveraging SARE funds with other public and private assistance to make a significant change in the quality of rural life for Hispanics, Native Pueblo Indians and other families on limited incomes.

Mapel's six-figure estimate refers to the market value of a recent harvest of organic wheat made by a farmer cooperative in Costilla, N.M. It's the inaugural crop for the growers after a generation of local people stopped farming in the area.

The small grain production project in Costilla is one of three hands-on efforts to re-teach Hispanic and Native Pueblo farmer cooperatives how to grow and market their products to boost their annual incomes and improve their quality of life.

Other initiatives to enhance sustainable agriculture in the region include a community garden project and food processing and marketing assistance at the Taos County Economic Development Center, both of which intend to jumpstart value-added agribusinesses.

"This revitalization project got started because the local people came to us and asked for help to make it happen," says Rey Torres of Taos County Extension. "It's been successful because we've combined the grassroots desires and interests of the community with a leadership team that emphasizes the strengths of its players."

The technical expertise of Extension linked with the marketing know-how of NMDA and the community activism of development center directors Terrie Bad Hand and Pati Martinson have combined to create diverse, de-centralized "incubators" for long-term economic success in the region, says Torres.

Lonnie Roybal, a Costilla landowner and first-time wheat grower, says farming is the only thing he and his neighbors can rely on.

His friend and cooperator Juan Montes agrees. "We're after a strong sustainable community that's not dependent on tourism or other up-and-down economies," he says.

Del Jimenez, sustainable agriculture specialist, expects far-reaching effects from the agricultural production efforts. "This work benefits more than just a few small towns. The organic wheat produced by the growers fuels niche markets for local mills and bakers, and launches a state product of organic flour that can be labeled as made and milled in New Mexico."

In another part of northern New Mexico, in the commercial kitchen at the Taos County Economic Development Center, "High Desert Delights" pastry chef Leslie Pedlar has fashioned a business out of baking brownies, cakes, cookies and other sweets for local restaurants and shops.

"I probably would have quit by now if this kitchen was not available," Pedlar says. "It's very difficult to find a restaurant kitchen that will accommodate a small operation like mine."

The kitchen Pedlar cooks in is part of a gleaming, up-to-code food processing center housed at the Taos Economic Development Center. Pedlar says combining reasonably-priced, accessible work space with the legal and financial services offered at the business park is a great way to give small enterprises like hers a fighting chance to succeed.

The dynamic team behind the development center business park are co-directors Bad Hand and Martinson. They carved out a strategy for community action in Taos County by investigating the desires and strengths of its citizens.

"You have to go to the people," says Bad Hand. "In this area, we learned that agriculture could be a seed of change because of its link to the people's heritages."

Looking to the future, Bad Hand and Martinson say they aim to get the development center's commercial kitchen functioning 24 hours a day with locally produced goods. They also plan to have its companion community garden act as an catalyst for more food business opportunities for limited-income women and others, as well as an entry point for healthy eating and nutritional education.

On the wheat production front, Mapel says he foresees a time when the farmer cooperatives in Costilla, Questa and Taos Pueblo will come to him and ask for help in marketing their grain, having planted it, tended it and harvested it on their own.

"By then, perhaps in the year 2000, they'll be producing a million pounds of organic wheat for the local economy," he says. —*Kristen Kelleher*

When a couple raising organic produce in Minnesota's Twin Cities area wanted to try a new weed-control strategy, they turned to an unusual source: a University of Minnesota (UMN) graduate program offering agricultural students practical, on-farm experiences. A student spent a semester gathering information for the farmers on flame weeders, discerning what was available and evaluating optimum burn intensities for efficient weed control.

The project became an ideal partnership for the farmers, who were seeking low-cost support for a relatively new organic technology, and a student desiring a sustainable agriculture curriculum that went beyond traditional classroom fare.

With an eye on UMN's innovative graduate-level offerings in sustainable agriculture, a group of SARE-funded professors and education advocates in three states are trying to create a similar educational experience for undergraduates. While on-farm internships for college students are becoming fairly common across the nation, the group wants to expand beyond traditional field labor work.

A plan to create an undergraduate minor in sustainable ag that's heavy on the practical could become a unique offering in American universities. While UMN already offers an undergradu-

UNIVERSITY OF MINNESOTA STUDENTS MAKE A NEARBY FARM THEIR CLASSROOM, PART OF A NEW PROGRAM TO TEACH SUSTAINABLE AGRICULTURE THROUGH PRACTICAL EXPERIENCE. PHOTO BY CRAIG SHEAFFER.

ate sustainable ag minor, it centers on a mix of existing agricultural coursework. Craig Sheaffer, a UMN agronomy professor who is leading the project, hopes to take it to a higher level, emulating the successful graduate-level curriculum that he and other educators say has lured students eager to get into the field and tackle real-life farming challenges.

"We want to put students in situations where they can learn from a whole new set of mentors," says Sheaffer, who is working with primary collaborators from Iowa State University, the Practical Farmers of Iowa and the Nebraska Sustainable Agriculture Society. "They'll have a diverse set of learning experiences where they may pick vegetables, they may milk cows or they may bale hay, but they would also interact with their hosts to learn about farm life or how a sustainable agriculture association works."

Sheaffer credits the project with allowing his group to redevelop and refine the sustainable agriculture programs in Minnesota, as well as across the region and even the nation.

"The sustainable ag minor at the graduate level certainly serves as an attractant — it made us come out of the woodwork," says Steve Simmons, a UMN professor of agronomy and plant genetics and director of agronomy graduate studies. Simmons asserts that most, if not all, of his graduate agronomy students in the last two to three years have come because they want a good graduate minor in sustainable ag.

"It's probably the most important feature of our curriculum," he says. "It attracts students to a traditional discipline like agronomy, as well as students from liberal arts and other backgrounds who are not normally interested in agriculture."

The curriculum will be piloted at UMN, Iowa State University and the University of Nebraska. Fifteen students will undertake the coursework, including six weeks of farm visits. If it is as successful as the project organizers hope, a full-fledged curriculum could be launched at the universities in 1998 or 1999.

The "experiential" learning concept expands on traditional university curricula that focuses on classroom research. Sending students into the field to work out problems in actual situations will give them a better flavor of the challenges involved in sustainable agriculture.

"STUDENTS MAY PICK VEGETABLES, THEY MAY MILK COWS OR THEY MAY BALE HAY, BUT THEY WOULD ALSO INTERACT WITH THEIR HOSTS TO LEARN ABOUT FARM LIFE OR HOW A SUSTAINABLE AGRICULTURE ASSOCIATION WORKS." — CRAIG SHEAFFER

The Twin Cities-area produce farmers, for example, wanted to learn about flaming because they needed an organic weed-control practice. Traditional agriculture curricula advise students to apply synthetic herbicides to control weeds.

Before an experience on a farm or at an advocacy organization, student advisers would organize meetings between the student and potential host to set parameters for the work. The meetings would define in advance what the student and host could expect to gain.

Beyond the farm experience, the curriculum would include a seminar course that helps students reflect about and process their field work back in the classroom.

Project organizers polled producers and representatives from sustainable agriculture nonprofit organizations across the North Central Region to ascertain who might host students. They then held workshops across the region that focused on experiential learning and instructional approaches for both educators as well as potential hosts.

Sheaffer hopes the momentum will infuse college-level educators across the country with an enthusiasm for experiential learning. "Too often, students learn how to conduct research at a university, but when they go to apply it, it doesn't fit all the time," Sheaffer says. "By having a minor in sustainable ag, we're trying to enhance existing programs and broaden a student's perspective on agriculture — and life." — *Valerie Berton*

Eight generations after the first Lyman began growing apples in 1741, the family has carved a small niche in the central Connecticut apple market.

That market share is tenuous, however, as orchard grower John Lyman faces competition his grandfather—or even father—never dreamed of. In prime New England apple season, local stores offer fruit shipped from New Zealand. Washington apples are trucked across the continent and marketed aggressively in stores, magazines and even the New York City subway.

While the Northeast region produces the nation's second largest apple crop, most stores stock out-of-state varieties. Few fruit-buyers think about the origin of the apples they buy, although they may later lament the disappearance of a farm down the road.

A SARE-funded educational project in New York and New England addresses that lack of understanding in the marketplace. Led by the New York City-based Mothers & Others for a Livable Planet, the project encourages consumers to buy local apples produced in an environmentally sound manner. The project offers a new type of apple cleverly dubbed "Core Values-Northeast"—fruit produced exclusively in the region using integrated pest management (IPM) strategies.

The Core Values campaign connects a pilot group of orchard growers with participating stores and offers information at the point of sale about IPM and the importance of buying locally. IPM features a variety of insect and disease control methods, such as encouraging the presence of beneficial insects or bacteria that prey on unwanted pests or scouting before spraying. Conventional growers often apply pesticides or spray according to a calendar, regardless of an actual pest outbreak. IPM also weighs the value of using a pesticide against potential crop loss.

Participating in the Core Values campaign "is our way of putting value onto our fresh product," says Lyman, one of the project's group of pilot growers. "If my family operation survives to a ninth generation and beyond, we have to find a way to sell more apples at a greater value. We have to capture the consumers who want to support growers who integrate their practices into the environment."

Mothers & Others, a national consumer education and advocacy organization, launched Core Values to stem the tide of disappearing farms in the Northeast. In 1994, New York and New England produced close to 32 million bushels of apples, second only to Washington. Project organizers want to strengthen the viability of the region's apple industry.

The New York metropolitan area obtains about three-quarters of its apples from outside the region. The intercontinental and transcontinental journeys of apples shipped from Washington or New Zealand require enormous amounts of fuel and contribute to poor air quality.

Project organizers want consumers to recognize local growers who voluntarily have reduced pesticides. IPM offers a middle ground between growing organically without synthetic pesticides and growing conventionally. The project involves a three-fold accreditation system to ensure growers raise fruit according to best management standards. Growers must submit a detailed farm plan and undergo an on-farm inspection. A five-member committee comprised of growers, IPM and apple experts, and a Mothers & Others consumer representative reviews each plan and inspection reports, then votes on whether to accredit the farm.

THE PROJECT ENCOURAGES CONSUMERS TO BUY LOCAL APPLES PRODUCED EXCLUSIVELY IN NEW YORK AND NEW ENGLAND IN AN ENVIRONMENTALLY SOUND MANNER.

A PUBLICITY CAMPAIGN TO BOOST SALES OF LOCAL APPLES INCLUDES A 30-SECOND TV SPOT. PHOTO COURTESY OF MOTHERS & OTHERS FOR A LIVABLE PLANET.

Project organizers hope the educational campaign will result in a dedicated group of buyers who might be willing to spend a little extra on Core Values apples to compensate farmers for that risk.

"What sets Core Values growers apart is gaining recognition from consumers that they use ecologically safe methods," says Francine Stephens, a Mothers & Others program associate. "By going into the stores with educational materials about IPM, the grower will ultimately benefit."

New Haven, Vt., grower Jim Gallot tries to grow apples "with as little impact on the environment as possible." That's despite investing up to 18 months in each apple crop, a period when a single insect pest or disease could ruin an entire crop. Wholesale spraying of a pesticide could possibly eradicate the problem.

"Why, with all that risk would a sane person want to push the envelop of pest control?" Gallot asks. "Because it's the right thing to do."

Gallot likes the way Core Values does not prescribe a single set of IPM practices.

"The emphasis is on how you come to your decision," he says. The initiative "lets people know these apples are grown by someone with the same values."

In 1997, 21 growers completed a whole-farm plan to be on the list to supply Core Values apples. The plans specify how each grower will supply nutrients and combat pests using methods that minimize application of agrichemicals. Close to 100 growers indicated interest in joining the project after the pilot portion concludes.

The year also saw the launching of a Mothers & Others educational campaign to introduce the idea of Core Values apples in the marketplace. In what Stephens describes as a "barnstorming tour," the organization sponsored a media blitz that featured visits to farms, restaurants and supermarkets from Vermont to New York. The tour garnered publicity in *The New York Times* and *Vegetarian Times* magazine, among other publications.

"Our ultimate goal is for consumers to recognize the logo and eventually ask for the Core Values apple," Stephens says. "New England farms are slowly disappearing, and we hope to build market support for local growers using IPM practices."

Project leaders will focus on schools in 1998, and hope to have public schools in several states buy Core Values apples and supply them to students.

Lyman, who describes himself as "very judicious" in how he uses chemicals, finds potential market expansion the most exciting thing to hit the industry since the negative publicity surrounding the Alar controversy in the late 1980s. Claims about the toxicity of the Alar pesticide prompted mothers across the country to stop buying apples.

"After being embroiled in food scares, anything we can do to address consumer concerns proactively is great," Lyman says. "We all work hard to produce a competitive grade. We also work hard to reduce pesticides, and we should get paid for that."

— *Valerie Berton*

Farmers in the South face challenges unique to growing in a climate that remains hot and moist most—if not all—of the year.

Cold winters in the North knock back many pest populations that thrive all year in the Deep South. California experiences winters as mild as those in the South, but its generally dry air holds some types of fungal diseases in check.

In the South, insects and fungi remain a virtually constant pair of threats most southern farmers combat with pesticides.

Southern farmers concerned about their impacts on natural resources, the ever-disappearing arsenal of registered pesticides and the high cost of buying and applying agri-chemicals have a new resource in *Sustainable Practices for Vegetable Production in the South,* a 174-page book that covers alternative practices from cover crops to integrated pest management (IPM). The book, a well-regarded publication whose research and development was financed by the SARE program, was published by Focus Publishing in 1996.

Mary Peet had been teaching vegetable crop production at North Carolina State University for close to 10 years when she decided she wanted to include material on sustainable and organic practices. "Although there is a lot of material on the theory and principles—the 'why' of sustainable agriculture—there didn't seem to be much practical information," says Peet, who researched and wrote the book. "It became a major project just to get access to this information."

With her research assistant, Sarah Slover, Peet began the arduous process of ferreting out available information, much of which at that time was anecdotal. They contacted farmers in the Carolina Farm Stewardship Association, held farmer focus groups and read everything they could get their hands on.

In the early 1990s, the growth of farmers markets and community-supported agriculture (CSA) farms led a groundswell of interest in sus-

MARY PEET'S BOOK ON SUSTAINABLE TECHNIQUES TO GROW VEGETABLES FILLS A NICHE IN THE SOUTH. PHOTO COURTESY OF NCSU.

tainable farming. Peet tried to ride the wave. A group of progressive North Carolina growers became key sources, both in supplying information and suggesting what they needed in a comprehensive book on vegetable growing.

The book's progress was not without challenges, however. University scientists reviewing text wanted to know the sources of information presented, so it became apparent they would have to develop a footnoting system. Peet was concerned that approach might satisfy the academics but put off more casual readers. After those early reviews, she re-organized her approach and several chapters.

"To me, practicing organic farming and sustainable agriculture requires a very holistic approach, not only in what the farmer does, but in how we present information to him," Peet says. "We felt there isn't just one right way to do something, but rather each farmer needed to work out his own solution to problems."

High-analysis fertilizers and pesticides will work pretty much the same everywhere, she says.

"With organic ag, there are no magic formulas like, 'Add 10 pounds of turkey litter per 1,000 square feet.' or 'Apply 50,000 Trichogramma wasps per acre' that will work in all situations," Peet says. "The organic grower needs to be much more aware of the fertility, pest and beneficial status of his own fields to make decisions than does the grower fertilizing and spraying by the calendar. We felt we needed to present concepts and guidelines that would help in their decision-making process."

"A PUBLICATION SUCH AS THIS HAS REALLY BROUGHT CREDIBILITY TO ORGANIC AND SUSTAINABLE FARMING." — ROBERT HADAD

To provide that context for growers, the book begins by laying out systems-oriented information, including soil management, cover crops, conservation tillage and IPM before delving into ways to raise common southern crops: beans, cabbage/ broccoli, cucumber, eggplant, muskmelon/watermelon, okra, pepper, potato, squash, sweet corn, sweet potato and tomato.

While some of the information is technical, Peet's style is easy to read. Sections on cover crops, IPM and alternative practices for growers are presented in an accessible, understandable format.

Tables provide a wealth of additional information. For example, one helps growers plan rotations by compiling diseases common to southern vegetables, weather conditions conducive to those diseases, means of transmission and suggested alternative controls.

The longest chart provides a detailed list of cover crops, which have the potential to improve soil health.

In addition to writing for farmers, Peet targets agricultural Extension educators. Many, she says, had difficulty helping clients interested in alternative agriculture as recently as five years ago because of lack of information.

"Most of the small farmers in our state that are interested in sustainability are predominantly organic growers," Robert Hadad of the University of Kentucky Extension Service told Peet in an e-mail. "I have been working at bringing them research and other current information about organic and sustainable farming practices. Finding this information usually has been a challenge. Seeing a publication such as yours has really brought credibility to this area of farming."

The book is augmented by a site on the World Wide Web, www2.ncsu.edu/sustainable/. The web site attracts numerous visitors, many of whom then contact Peet.

"Your web site is the most informative resource I have found for a novice vegetable farmer," wrote Ken Stanley, who planned to move to a 110-acre farm in Tennessee. "Now I truly understand...the learning curve required for me to achieve my goal."

A Natural Resources Conservation Service (NRCS) agronomist looking for materials to host a field training on sustainable agriculture wrote Peet to ask for permission to reprint portions of the book.

"All the effort you put into the book was well worth it," wrote Janet Sioma of NRCS in Beltsville, MD. "In your preface you talk about how little technical information is really out there. You were right on the money, as I have seen in requests from our field staff. They want hard-core technical information on sustainable practices."

The book is available from PBS, Box 390, Jaffrey, N.H. 03452 (1-800-848-7236).

— *Valerie Berton*

One Montana-style recipe for sustainable agriculture: Sow high-protein wheat with an advanced air drill, grow it under conservation tillage, harvest, then dough it into 8,000 loaves of bread a day. At Wheat Montana Farms & Bakery in Three Forks, the formula is an enormous success.

With $3.5 million in annual business, Wheat Montana isn't exactly your neighborhood co-op. But it illustrates just how wide-ranging sustainable agriculture can be.

"A lot of people think sustainable farming isn't technical," says Dean Folkvord, a partner in the family-owned enterprise. "In reality, there's more to manage, especially at this volume."

Farmers like Folkvord know a lot about the emergent field of sustainable agriculture. SARE-funded training of agricultural professionals in five Western states aims to make a connection between those innovative producers and Extension and Natural Resource Conservation Service (NRCS) field staff who have provided information about traditional production for decades.

The training, led by the Alternative Energy Resources Organization (AERO) in Helena, Mont., had two goals: to provide information about sustainable agricultural production and help participants find new ways of learning from each other.

The Montana-based trainers also encouraged producers to team up in "farm improvement clubs" to learn more about sustainable agriculture, rather than working out solutions individually on their farms.

"Collaborative learning represents a shift in thinking from the tradition of someone coming to an expert for advice," explains Stephanie Rittmann, training program coordinator. "Instead, agency professionals and producers become co-learners and peers. They learn to recognize each others' skills and assets, be open to each others' ideas, ask questions and learn from each other."

This approach means rethinking the role of conservationists, Extension agents and other agency professionals.

"We're redefining an agent as a good facilitator, an educator who knows how to make the most of the skills, talents and knowledge that exist within a community and bring those alive," Rittmann says.

Working through established farm and ranch improvement clubs in three states, AERO also encourages producers to experiment and solve problems together. The clubs, in Montana, Idaho and eastern Washington state, essentially serve as farmer networks, bringing together producers with similar interests to share information and solve common problems.

"We hoped to eliminate some of the isolation farmers feel when they're trying something new," Rittmann says. "It's much easier growing lentils in an area where lentils have never been grown before if you've got five other buddies doing the same thing."

Farmers and ranchers were involved in every step of the two-year training project. The first year's activities, conducted in Montana, featured a conference that focused on principles of sustainable agriculture and tours of exemplary farms that demonstrated how those principles work. AERO also offered an alternative weed management conference that emphasized problem-solving. Follow-up training involved on-farm research, and an annual farm and ranch improvement club meeting offered a chance for collaboration.

In all, more than 100 people from agencies and land-grant universities attended all or part of the Montana

WORKING THROUGH FARM AND RANCH IMPROVEMENT CLUBS IN IDAHO, MONTANA AND EASTERN WASHINGTON STATE, AERO ENCOURAGES PRODUCERS TO EXPERIMENT AND SOLVE PROBLEMS TOGETHER.

FARMERS AND AGRICULTURAL EDUCATORS LEARN MORE ABOUT A COW/CALF GRAZING SYSTEM IN FEGUS COUNTY, MONT. PHOTO COURTESY OF WESTERN REGION SARE.

training, which planted the seeds for a regional network of professionals involved in sustainable agriculture.

Participants probably gained the most from an illuminating tour of three farms and ranches that have built successful, sustainable enterprises around common commodities in the region.

"We wanted to answer the question, 'What does sustainable agriculture look like?'" Rittmann says. While many people think sustainable agriculture is synonymous with certified organic production, the tour showed a variety of options.

The first stop was Wheat Montana Farms & Bakery in Three Forks, where the Folkvord family combines large-scale grain production with value-added processing. The farm uses no-till and conservation tillage to produce herbicide-free wheat grown with some purchased fertilizers.They sell fresh bread produced in their on-farm bakery to customers nationwide.

At the Seven Bar Heart Ranch in Ulm, where Greg Gould and Aimee Hachigian raise registered Angus cows and calves, tour participants viewed an innovative integrated cropping and grazing system that relies heavily on a mix of marketing strategies.

Gould and Hachigian grow a variety of forage crops on 90 percent of their land, with 10 percent planted in grain and specialty crops. Some of the ranch's cattle meet organic guidelines; others are sold through conventional channels. Gould and Hachigian also sell organic wheat to a Montana company and organically grown buckwheat to the Netherlands through a cooperative. The final stop on the tour was the Quinn family farm and ranch, a certified organic operation in Big Sandy that grows winter wheat, lentils, buckwheat, alfalfa and kamut, an ancient Egyptian grain. The Quinns grow, buy and process organic grain for pasta they market to 30 states and 10 foreign countries through their own mill, Montana Flour and Grains Inc.

"We wanted to show sustainable agriculture is not a set of practices, it's an ongoing process," Rittmann says.

Many trainees were enthusiastic about what they learned, especially outside the classroom. They later told AERO that their participation gave sustainable agriculture a higher profile in their organizations.

Fittingly, AERO organizers themselves learned important lessons they were able to incorporate in the following year's training in Idaho. From the start, organizers involved agencies in planning the training, giving participants input and ownership. Trainers added a session on how to talk to constituents about sustainable agriculture.

A year into the project, Nancy Taylor, coordinator of northern Idaho's farm improvement clubs, could already see results from the connections made during the training.

"This year, farm clubs are telling me that it has been much easier to garner support from local Extension agents and resource conservationists for their work," she says.

Though not all participants embraced the new ideas and approaches, some carried out similar training within their own organizations.

AERO trainers hope the next time conservationists and Extension agents get inquiries about sustainable agriculture, they'll remember the aroma of 8,000 loaves of bread baking in Three Forks, and feel comfortable calling people like Dean Folkvord with their questions and referrals. —*D'Lyn Ford*

When a natural disturbance occurs—from an event as large as a landslide to as small as a tree falling in a forest—it can wreak havoc on the animal, plant and insect populations in that ecosystem.

Agricultural landscapes, disturbed regularly by tilling, planting, cultivating and harvesting, can throw the insect world into disarray. Often, such activities kill off beneficial insects that prey on crop pests. The beneficials usually do not rebound as quickly as pests adapted to agricultural disturbances.

ON ROBERT BURNS' FIELD, WHERE SARE RESEARCHERS TESTED FILTER STRIPS, THE FARMER NOTICED FEWER INSECTS AND STOPPED SPRAYING INSECTICIDES, SAVING $6 TO $10 PER ACRE.

"When farmers disturb the habitat of the crop field, it resets the succession of ecological processes, so a series of animal and plants invade, some of which are weeds and insect pests," says Doug Landis, a Michigan State University researcher who, along with colleagues Karen Renner and Paul Marino, received a SARE grant to study ways of attracting beneficial insects into agricultural landscapes. "Natural enemies have to wait for the pest populations to come back, so they are always one step behind.

"Where we're farming road to road without leaving any undisturbed habitat, it's harder for natural enemies to move back."

Landis, other Michigan State researchers and cooperating farmers are working to better understand just how intensive agriculture affects the insect world. By minimizing the disastrous impacts crop farming can have on beneficial insect populations, the researchers hope to identify ways for growers to reduce their use of synthetic pesticides.

More specifically, they are studying whether retaining or creating undisturbed areas on farms may harbor beneficial insects that will help keep pest populations in check.

In one study, Landis worked with farmers who have created filter strips along field edges to catch runoff. Promoted by the Natural Resources Conservation Service (NRCS), which will share the cost of installing the vegetative buffers, filter strips can improve water quality off farm. Landis theorized that the filter strips, with a mix of native vegetation undisturbed by the plow, would harbor beneficial insects.

Robert Burns, who raises corn, wheat and soybeans on 250 acres near Midland, Mich., installed filter strips of either legumes and grass or switchgrass in 1995 to minimize his farm's runoff into nearby Bluff Creek. Water flowing into the creek, after emptying into two Michigan rivers, eventually empties into Saginaw Bay and Lake Huron.

"In the spring, or any time you get high water, the runoff takes fertilizers and whatever else in it to the creek," Burns says. "This way, it has to go through this grassy-type alfalfa stand, and it filters the water. Before, you'd have a lot of muddy water and dirt. Now it's more clear."

Landis worked with Burns to test which of the farmer's two 100-feet-wide strips would shelter more beneficial insects. He looked in particular for ground beetles, which not only prey on insect pests, but ingest many types of weed seeds as well.

"Ground beetles are ubiquitous in all terrestrial ecosystems in North America and probably the world," he says.

"In a very conventional farming system, you would still have ground beetles present, but there would be fewer species and probably a lower abundance because you're disturbing that habitat frequently."

Landis found the switchgrass—a native, warm-season grass with tall, stiff stems—contained 38 ground beetle species. By contrast, the alfalfa mixture turned up 29 ground beetle species and the adjacent soybean field just 25.

When he tested the beetles' proclivity to eat weed seeds, Landis found they destroyed 84 percent of foxtail, a pervasive weed, in one week alone in the switchgrass strips versus only 17 percent in the soybean field far away. Encouraged, Landis hopes to study how well the beetles migrate from the filter strips into the crop field.

"Farmers are already creating these habitats to catch runoff," he says. "For biological control, their potential has been largely unrealized."

Landis also studied whether refuge strips comprised of cover crops and perennial plants would similarly attract ground beetles. On several Michigan farms, he created 10-feet-wide strips of clover, grass and perennials, offering a mix he hoped would prove attractive habitat. The refuge strips were placed in plots opposite fields without the refuge vegetation to test which areas the beetles would prefer.

Refuge strips comprised of orchard grass, clovers and perennial flowering plants sheltered greater numbers of beetles than the control area. Adding red clover, frost-seeded into oats, increased beetle abundance in some periods.

"A lot of ground beetles overwinter in the strips," Landis said. "Refuge strips have a lot of dead plant material and they are insulated with snow. In the spring, the beetles move into the crop to seek food."

There, he found, the beetles removed more than 40 weed seeds per square foot per day.

On Burns' field, where they tested existing filter strips, the farmer has noticed fewer insects since he planted the strips. In fact, he stopped spraying insecticides in his field after planting the strips, saving him $6 to $10 per acre.

"You're going to have bugs, but the strips give the beneficials a good place to harbor because it's dense and you don't work it up, so it has a chance to build up," he says. "However we can get away from sprays and weed killers and figure out ways to make nature help us instead of work against us is a step in the right direction."

— Valerie Berton

RESEARCHERS DOUG LANDIS AND DORA CARMONA COUNT GROUND BEETLES IN A VEGETATIVE REFUGE STRIP PLANTED TO ATTRACT INSECT PREDATORS. PHOTO BY BOB NEUMANN.

The Northeast Region is prime apple-growing territory. In 1995, the nation's most popular fruit brought about $222 million to the Northeast apple industry.

Apples are good to the region: The fruit often is grown on hilly land that might not otherwise be farmed, the apple industry provides steady jobs, and orchards contribute to a working farm landscape prized by tourists, especially in the autumn.

But apples are tough to grow without synthetic pesticides. Not native to North America, apples are beset by a rash of diseases and insects that can destroy or blight them, causing today's consumers to pass them up.

Apple scab, for instance, remains a serious disease for apple growers. In Vermont alone, it costs growers about $1 million a year in pesticides and other controls.

The devastating fungus was one impetus for a group of Northeast researchers from Vermont to Pennsylvania to collaborate in Northeast Region SARE's longest-running, most comprehensive project. Their goal: to identify more sustainable ways of growing apples.

Researchers hoped to develop a sustainable production system that focuses on apple varieties naturally resistant to some of the tree's most plaguing pests and diseases. They conducted detailed economic analyses to determine whether replacing expensive synthetic treatments with integrated pest management (IPM) strategies would benefit farmers' pocketbooks, while evaluating the impact of fewer chemicals on soil, water and wildlife around the orchard ecosystem.

The project—first led by Lorraine Berkett, plant and soil scientist at the University of Vermont, then Terry Schettini, formerly of Rodale Institute—planted, grew and evaluated more than 30 cultivars, or types, on 5,000 trees over the eight years of the project. Collaborators at Pennsylvania's Rodale Institute, Cornell University, Rutgers University, the University of Massachusetts and growers in four states all contributed to the research effort, the first effort of its kind on such a large scale.

"Our group was really the first to take a look at how

APPLE RESEARCHERS FOUND HIGH RATES OF FUNGICIDE CAN KILL SOME OF THE BENEFICIAL INSECTS—SUCH AS THIS LADY BEETLE LARVAE—THAT PREY ON FRUIT-DAMAGING PESTS. PHOTO COURTESY OF NORTHEAST REGION SARE.

scab-resistant cultivars fit into commercial enterprises," says David Rosenberger, associate professor of plant pathology at Cornell's Hudson Valley Laboratory.

Project results, in many ways, were encouraging.

The methods project participants used to assess cultivars with immunities to apple scab so impressed experts in the field that a national evaluation process based on their work is being established that includes 22 cultivars in 18 states.

Berkett and her colleagues found that fungicide usage can be reduced by 50 to 100 percent with scab-resistant cultivars. By using other IPM methods, a savings of $200 per acre in direct pesticide costs can be achieved. IPM involves a variety of insect and disease controls, such as encouraging the presence of beneficial insects or bacteria that prey on unwanted pests, scouting before spraying and weighing the value of using a pesticide against potential crop loss.

Apple producers have responded. Over the course of the project, more than 15 growers have established plantings of cultivars recommended by the research team. Many more commercial growers adopted IPM techniques; 75 percent of the apple acreage in Massachusetts alone now is managed under IPM.

Grower Jim Gallot of New Haven, Vt., planted several experimental varieties in his 30-acre West Meadows Orchard as part of the project. Gallot is confident the project will help lead to better cultivars because of the way the project has influenced the industry and other apple scientists.

"We've learned quite a bit from the research," Gallot says. "Instead of just asking, 'What can we do with Macintosh?' we're thinking about apple-growing in a new way. It's very important to keep pushing the limits and trying things."

Fungicide research revealed such important data as the minimum amount of fungicide farmers actually need. Synthetic fungicides can impact the orchard system environment in complex ways — researchers found high rates killed some of the beneficial insects that preyed on apple mites.

"In dropping some fungicides, we learned things we didn't even suspect before, like some were having a negative effect on mite predators," Gallot says. "Fungicides aren't as benign on the insect and predatory ecology as we thought. They affect other things, too, in ways we never imagined."

SARE RESEARCHERS FOUND THAT FUNGICIDE USAGE CAN BE REDUCED BY 50 TO 100 PERCENT WITH SCAB-RESISTANT APPLE CULTIVARS.

The research spanned a range of climates and growing conditions from the mid-Atlantic to northern New England. Project participants also learned more about optimum apple marketing strategies, from retailing at roadside stands to wholesaling to large processors.

The breadth of the work aided in the completeness of the project, Berkett says.

"It's almost a new way of doing business, with people from many disciplines and different states working together," she says. "Within the region, we have different production systems, different climates and different cultivars."

One of the project's findings on a regional scale proved disappointing: Many of the scab-resistant varieties the researchers recommend face serious obstacles. Some cultivars attract other insect pests or diseases; others do not store well or may have trouble catching consumers' eyes in the marketplace.

Despite the potential negatives, most of the project findings have been well received by apple and IPM specialists throughout the region. New information quickly spread to state apple IPM programs.

In Massachusetts, data from the study was included in a project to develop IPM strategies for combatting sooty blotch and flyspeck, a serious disease in southern New England.

In New York, researchers discovered that fungicide applications could be delayed from two to three weeks and still control flyspeck.

And in Vermont, studies on the use of T. pyri, a predatory insect that can help control the damaging spider mite, continues.

Project participants produced a comprehensive reference, "The Management Guide for Low-Input Sustainable Apple Production," in 1990. They also developed a newsletter — the only publication in the Northeast devoted to alternative apple production — and a World Wide Web site called "The Virtual Orchard."

— *Susan Harlow*

For years, the desired standard for cotton farming has been a kind of tidiness bordering on sterility: nothing but clean-tilled ground between rows and along field edges before and after each crop.

With no extra vegetation, insect pests had no place to hide.

IT SEEMS CLEAR THAT THE USE OF A LEGUMINOUS COVER CROP, ALONG WITH CONSERVATION-TILLAGE OR NO-TILL, LEADS TO FEWER CROP-DESTROYING PESTS.

It went against deeply held beliefs, then, when entomologist Joe Lewis and horticulturist Sharad Phatak suggested in 1993 that cotton farmers may be better off using cover crops and vegetative refugia strips, thereby encouraging all kinds of insects to take up residence in and around their crops.

The two had a hard time convincing any of the south central Georgia growers they had worked with over the years to even experiment with their new system, but Benny Johnston finally told them he'd give it a shot.

The willingness of Johnston and his son, who raise about 900 acres of cotton near Tifton, about 60 miles north of the Florida line, to go along with Lewis and Phatak's ideas surprised both scientists.

"Benny Johnston's a real good, by-the-book kind of farmer," Lewis said. "I didn't think he'd be comfortable having any other vegetation growing in his fields when it came time to plant cotton."

But like a lot of other cotton growers, no matter how conventional, Johnston was looking for ways to reduce his use of chemical pesticides, for some very compelling reasons: The cost of inputs keeps rising while the market for chemically treated cotton shrinks.

As Lewis explains it, U.S. cotton production already has weathered three historic boom and bust cycles. The first major blow to the industry coincided with the collapse of the southern economy in the wake of the Civil War. The next plummet rode in on the hard-shell back of the boll weevil during the early 1920s followed by the hardscrabble days of the Depression.

The boom started with a chemical input-fueled bang after World War II. And it was during those hard-driving days that Johnston began farming. His yields increased initially, but so did his need for applications of increasingly expensive synthetic fertilizers, herbicides and pesticides. Then the chemical inputs grew less and less effective, and his yields began dropping despite increased applications.

Similar results already had begun to drive other cotton farmers out of production, and once again, in the 1970s and early '80s, the southern cotton industry fell on hard times.

Johnston stuck with cotton, but he was looking for a better way and was willing to believe Lewis and Phatak might have found it. After receiving a SARE producer grant in 1994, he lent a 20-acre plot to the cover crop and refugia strip experiment, using the grant to lease the conservation-tillage equipment he'd never needed before.

The plan was to attract and retain sufficient populations of the kind of insects that feed on and control cotton pests. The results have been more than encouraging.

Lewis, a research entomologist with the USDA's Agricultural Research Service, says it seems clear that the use of a leguminous cover crop — crimson clover in Johnston's case — along with conservation-tillage or no-till, leads to fewer crop-destroying pests. Johnston's conventional crop received five applications of pesticide per season during the trials, while the cover-cropped and refugia-stripped fields needed only two.

Lewis sees these results — along with the virtual eradication of the boll weevil in North America — as the gene-

sis of the newest boom in American cotton production, a boom he's hoping will be much more sustainable than those preceding it.

"We licked the boll weevil in certain parts of the Cotton Belt with a tough eradication program in the 1980s," Lewis says. "And now we're finding we can encourage the kinds of beneficials, including ants and spiders, that help control all the other cotton pests."

As it turns out, fire ants and other Central American interlopers like the boll weevil appear to be desirable predators in a cotton field given the right circumstances. Lewis isn't certain whether they are encouraged by the choice of a cover crop—crimson clover, in Johnson's case—or the fact that their nests are left relatively undisturbed when clear-tilling is foregone.

Whatever the case, Benny Johnston appears to have proven that a sufficient population of fire ants, along with a mix of native spiders and a variety of other beneficials, can hold infestations of common cotton pests such as aphids, bollworms, armyworms, budworms and stinkbugs to manageable levels.

And that's making more than chemical-weary cotton farmers happy. Patagonia, a manufacturer of sport clothing, recently announced its intent to purchase only organic cotton. Other upscale manufacturers are expected to follow suit.

If the innovative practices begun on Benny Johnston's farm take hold across the Cotton Belt, these companies shouldn't have to look far for the product they want. And farmers may be able to pull in premium prices for their cotton.

As for Lewis and Phatak, further experiments are convincing them that cover crops alone may be the better approach to sustained yields and sustained beneficial bug populations.

"At first," Lewis says, "we thought you had to have a pretty high concentration of refugia strips worked into the crop to keep the insect density high enough to be effective, and that's going to limit the room you have for planting your crop. But now we're thinking you can achieve the same effect or better with the use of cover across the entire field. When it comes time to sow cotton, you keep the cover on and just drill narrow bands through it for planting."

Farmers benefit from reduced erosion, more organic residue after the cover matures and dies, less nutrient leaching, a natural weed suppressant and a great place to attract and grow the bugs that will eat unwanted pests.

Lewis says his attempts to change the way cotton farmers feel about insects and cover is driven by a belief that a truly balanced ecosystem—which isn't possible under the "chemical umbrella" cotton farming's existed under for 40 years—will provide long-lasting benefits for both growers and the environment.

—David Mudd

PLANTING CRIMSON CLOVER AND REDUCING TILLAGE ALLOWS COTTON GROWER BENNY JOHNSTON TO REDUCE SEASONAL PESTICIDE USE FROM FIVE APPLICATIONS TO TWO. PHOTO BY GWEN ROLAND.

Western winter wheat growers have a deep desire to uproot an invasive, persistent weed called jointed goatgrass. They plow it under, burn it off, mow it down and change crop rotations.

Despite their best efforts, jointed goatgrass infests at least 5 million acres in wheat-growing areas from Washington to Texas and causes more than $145 million in losses each year. As farmers' frustrations grow, so does the jointed goatgrass, which has gained ground rapidly over the past 20 years.

THE BACTERIA, CALLED PSEUDOMONADS, ATTACK THE ROOTS OF JOINTED GOATGRASS. SOME OF THE BACTERIA SUPPRESSED WEED GROWTH BY 30 TO 70 PERCENT.

"It is such a tremendously fast-spreading weed, it can take over a field and ruin the quality of your wheat crop," says Eddie Johnson, a small grain producer from Wilbur, Wash. "Some of the fields in the Palouse region have 20- to 30-percent goatgrass infestations."

In dryland production areas of the Pacific Northwest, where annual rainfall ranges from 8 to 24 inches, jointed goatgrass steals moisture from winter wheat, reducing yields dramatically. Just a few weeds per square foot can cut yields by 25 percent. Even losses of 50 percent are common.

At the grain elevator, wheat with jointed goatgrass seed can be downgraded from top-quality export wheat to feed grain at a loss of a dollar per bushel. "At 50 bushels per acre, it adds up quickly," says Johnson, who has battled jointed goatgrass in some of his own fields for more than five years.

To find better options, Johnson and other growers cheerfully have donated some of their weedy wheat to the innovative research of Ann Kennedy of USDA's Agricultural Research Service housed at Washington State University. A soil microbiologist, Kennedy works with bacteria that slow the growth of jointed goatgrass but leave wheat alone.

"We're taking bacteria from the soil, culturing them in the lab, applying them back on the field at higher rates and having a negative effect on weeds," she explains. The bacteria she uses, called pseudomonads, attack the roots of jointed goatgrass, inhibiting its growth, while leaving wheat unscathed.

What makes jointed goatgrass so tough to deal with is its close kinship to wheat. Both crop and grassy weed share a common set of chromosomes and similar germination and growth patterns. In the field, it's hard to tell the two apart before they mature.

No available herbicide can effectively take out jointed goatgrass without harming wheat. If farmers turn to intensive tillage to get rid of the weed, they increase erosion. If they shift to spring cropping, they limit their profits and diversification.

With the SARE grant, Kennedy tested six promising bacterial isolates, first in the greenhouse and then in the field. Compared with the dramatic effects of herbicides, her biological weed control appeared to just "nick" jointed goatgrass, she says. But some of the bacteria suppressed weed growth by 30 to 70 percent—enough to give wheat a competitive advantage.

"The interesting thing is that you don't have to kill off a weed totally and you don't have to have a clean field to have a good crop," Kennedy says. "Any time that we can suppress jointed goatgrass growth by 40 percent or more, we generally see an increase in yields."

WINTER WHEAT GROWERS FIGHTING JOINTED GOATGRASS WEEDS WITH SOIL BACTERIA COULD REDUCE TILLAGE COSTS AND HERBICIDE USE. USDA PHOTO.

Kennedy's research showed wheat yield increases of up to 16 percent when weed growth was stunted by at least 40 percent. When bacteria were combined with less-than-lethal doses of herbicide, she says, the "double whammy" inhibited jointed goatgrass' growth even more.

For growers, managing jointed goatgrass with natural soil bacteria could help reduce costs, tillage and herbicide use. Using less herbicide could reduce the risk of groundwater contamination.

Using bacteria also could make conservation tillage a viable option. Applying the bacteria to fields is fairly simple and doesn't require sophisticated equipment, Kennedy says.

In the ground, the added soil bacteria survive just long enough to accomplish their weed control mission, dying off as temperatures rise.

Although bacteria must be reapplied to the soil each year, that protects the environment, Kennedy says. "Ecologically speaking, it's better not to make any permanent changes."

Another promising finding was that some bacteria reduced jointed goatgrass seed production, which could help curtail its rapid advance across the West. The joints of the annual weed shatter into seed spikelets that are carried by wind, equipment and animals. In loads of grain, the lighter-than-wheat weed seeds stay on top, where they can blow into new fields. Once established in soil, jointed goatgrass seeds can survive for years.

Within the next decade, Kennedy is hopeful that the soil will yield commercially available weed-fighting bacteria. However, she found that jointed goatgrass samples collected throughout the West varied in their responses to soil bacteria. More research will be needed to find a solution.

Another key will be educating producers to accept less than 100-percent weed control with biology and teaching them how to care for soil bacteria.

"When I work with growers, I tell them that agri-microbials like these are living organisms," Kennedy says. "You can't just leave them on the dashboard of the pickup and assume they are going to live."

Johnson thinks producers will be glad to learn more about a new ally against jointed goatgrass. "And, this is a natural, sustainable way of using our own soil."

—D'Lyn Ford

Agricultural pests and diseases ranging from apple scab to maggot flies pose major problems for apple growers who want to reduce or eliminate pesticides.

For Eric Carlson, who is trying to cut back his use of synthetic chemicals to create a more sustainable orchard ecosystem, tackling those tough pests in his Wisconsin orchard with alternative means became his top priority.

ERIC CARLSON PLACED STICKY TRAPS AROUND THE ORCHARD'S PERIMETER TO HELP SNARE APPLE MAGGOT FLIES WITHOUT INSECTICIDES. PHOTO BY KEN SCHNEIDER.

"I want to grow apples as sustainably as possible," says Carlson, who also raises blueberries, raspberries and fresh-cut and everlasting flowers on his 10 cultivated acres. "I can usually get good quality fruit with just one or two sprays. With some growers one or two dozen sprays isn't unheard of." Many of those applications are tank mixes of two or more insecticides and fungicides, he adds.

With the help of a SARE producer grant, Carlson found that some of the popular organic fungus control practices didn't work on disease-prone varieties in his orchard. But his research has led him to integrated pest management (IPM) practices that provide acceptable control of insect damage with a minimum of spray.

Carlson tested scab remedies in a planting of Cortland apples he had managed organically for two years and under a reduced spray program for two years before that. Cortlands are very susceptible to scab, a fungal disease that plagues growers particularly in the Midwest and Northeast. The fungus leaves dark blotches or lesions on leaves and fruit, making them unfit for fresh market sales.

When Carlson applied elemental sulfur to the trees at regular intervals or after rain, he saw very little scab. But disease pressure was admittedly light because of dry conditions during the season of the study.

While sulfur applications are standard practice for many organic orchardists, they concern Carlson.

"Applying sulfur may be considered organic, but I don't think it's sustainable," he says. "Every time you spray, that's 6 pounds of sulfur per acre that ends up in the soil, lowers the pH and affects the soil microorganisms."

Hoping for an even gentler way to tame scab, Carlson also tested a treatment that has little or no effect on

the soil. He sprayed dilute hydrogen peroxide to sterilize plant surfaces shortly after scab infection periods began. Unfortunately, those concentrations damaged the fruit and still did not completely control the scab — even with low disease pressure.

With both disease control remedies proving either ineffective or unsustainable, Carlson decided to try varieties that are naturally resistant to the disease.

He planted 1,000 scab-resistant trees using varieties such as 'Priscilla,' 'Liberty' and 'Sweet 16' that he expects will produce good quality fruit with little or no fungicide in most years.

For those scab-prone varieties already in the orchard when he moved there in 1989, Carlson now uses carefully timed applications of synthetic fungicides. By tracking air temperature and leaf surface moisture, Carlson is able to predict when scab infections are likely to occur and reduce his sprays by at least 30 percent compared with conventional operations.

Carlson also found that placing sticky traps around the orchard's perimeter helps snare apple maggot flies, one of the most pernicious insect pests. He spaces the round red traps 15 feet apart. Females heading for Carlson's trees mistake the traps for apples, and after landing on them, permanently adhere to the surface.

"We don't get 100-percent control," observes Carlson, adding that his maggot damage is usually between 3 and 5 percent, compared to about 1 percent for most conventional operations. "But by using the traps to control maggots, there's no reason to use insecticides after June, while conventional operations will have to keep spraying all summer."

Reducing the number of sprays may encourage populations of beneficial insects that prey on pests.

Codling moths, however, still plague Carlson. As part of his study, he placed lures throughout the orchard that emit very small amounts of chemicals — called pheromones — that females use to attract males for mating. The lures confuse the males, making it difficult for them to find females, and result in fewer matings.

Carlson then charted growing degree days to carefully time a spray of ryania, a botanical insecticide, to hit the next generation of moths when they were most vulnerable.

But it didn't work. Carlson still registered 30- to 50-percent fruit damage.

"At $200 per acre for the pheromone lures, I just couldn't justify it," he says, speculating that part of the problem might have been female moths flocking to Carlson's trees from a nearby neglected orchard that has since been destroyed.

"But with all the wild apples growing around here, I might never be able to control migrating codling moths without some insecticide," he says.

For now, Carlson has settled for using one or two applications of Imidan, a relatively short-lived organophosphate insecticide that has curtailed his codling moths quite successfully. As with the ryania sprays he tried before, he times the applications based on when the pest is most vulnerable.

"Soon my new scab-resistant varieties will start producing," Carlson says. "I've managed them organically so far. I'll have to wait and see what kind of quality fruit I can get from them before I decide if I need to spray them."

As a part of the project, Carlson has held field days and developed posters and information packets to share his findings with other growers and the public.

"THE REALLY GOOD GROWERS CAN TAKE THIS INFORMATION AND USE IT TO SAVE CONSIDERABLE AMOUNTS OF MONEY." — ERIC CARLSON

A Bayfield County, Wis., agent who attended one of Carlson's field days praised the grower for working so diligently to identify more sustainable strategies to manage pests. Says John Markus: "We as an industry need to look at disease and insect resistant plants to decrease our reliance on chemical use."

Carlson hopes the work will pay off in more farmer acceptance of alternative strategies.

"The really good growers can take this information and use it to save considerable amounts of money," he says. "But they have to be willing to take the time to learn about the life cycles of the insects, and go out and walk around their orchards and see what's going on. They can't expect to just do it on the weekend."

— *Craig Cramer*

Grape grower James Mohart knew he had better things to spend money on than spraying his crop. Time and expense dictated a new system.

"The sprayer is one piece of equipment that costs me $300 every time I pull it out," he says. "I'd rather put that money in my pocket."

Trying to improve his bottom line, Mohart, a part-time Irving, N.Y., farmer, undertook a SARE-funded producer project to test whether a weather station in his vineyard, combined with a computer modeling program, could predict when the grapes are most susceptible to two major diseases. After three years, he found the $1,200 weather station and accompanying modeling saved him between $31 and $36 per acre a year in the cost of spraying fungicides.

AFTER THREE YEARS, FARMER JAMES MOHART FOUND THAT THE $1,200 WEATHER STATION AND ACCOMPANYING MODELING SAVED HIM BETWEEN $31 AND $36 PER ACRE A YEAR IN THE COST OF SPRAYING FUNGICIDES.

Mohart grows 16 acres of grapes in a vineyard first planted by his father in 1971. The grape-growing region of western New York, which stretches from Niagara County south to Pennsylvania along Lake Erie, encompasses 30,000 acres. The lake moderates the climate, delaying bud break in the spring, protecting the buds from freezing and postponing the fall's first frost.

Most growers raise Concord grapes for juice; some of the largest U.S. grape juice processors, such as Welch's Growers' Cooperative and Mogen David Wine Co., have processing plants here.

While the region's climate is excellent for growing grapes, black rot and powdery mildew remain the two most devastating diseases of Concord grapes. Black rot can destroy an entire crop and powdery mildew can reduce sugar levels, rendering grapes fit only for vinegar.

Grape growers usually protect their vineyards from those diseases by applying fungicides at regular intervals throughout the season, usually spraying three or four times. Encouraging growers to use weather data and computer-generated predictions to cut down on the number of fungicide sprays, and to spray only during the critical post-bloom period would mean big financial savings for the farmers and much fewer pesticides being dumped into the environment.

It seemed like a winning situation to Tim Weigle, integrated pest management specialist for Cornell Cooperative Extension, who collaborated with Mohart on the project. Weigle reviewed research on pest biology and work he had done using computer models to predict disease infection periods.

With Mohart, Weigle wanted to monitor for climatic conditions most conducive to the disease spores of black rot and powdery mildew using a weather station. Then, he wanted to test spraying only when it would be most effective.

Ideal conditions for infection by powdery mildew spores, for example, exist when the temperature reaches 50 degrees F and one-tenth inch of rain falls. "By monitoring, you spray only when you need it," Weigle says.

The weather station in Mohart's vineyard registered such data as precipitation, temperature and leaf wetness. Plugging that information into a computer model told him

WHILE WESTERN NEW YORK'S CLIMATE IS EXCELLENT FOR GRAPE-GROWING, BLACK ROT AND POWDERY MILDEW REMAIN CONSTANT DISEASE THREATS. USDA PHOTO.

when it was an ideal time to spray. "Instead of spraying every 14 days, the weather station tells you that you may be able to put it off for three or four days," Mohart says.

Concord grapes are susceptible to disease in the crucial weeks before verasion, or the point at which the sugar content of the grapes is about 5 percent and the berries change from green to purple. After that, the fruit becomes immune from the diseases.

"As soon as you hit verasion, you're home free," Mohart says. "If you can get away with just two sprays before that, you're golden."

The system still has some limitations. For instance, once the ideal weather conditions are reached, a grower has just 72 hours to get the fungicide on the grapes.

"I can spray my 16 acres in one day, but if you're a larger operation, you may not have the manpower to do it all," Mohart says. "But if it keeps raining or your equipment breaks down, you're in trouble."

Weigle is developing computer models that can use data from the weather stations to predict the best time to spray for harmful insects like grape berry moth and Eastern grape leafhopper, as well as diseases. He is putting together an extensive network of stations throughout the grape-growing regions so that not every grower would have to have a station in his or her vineyard. Instead, they could tap into relevant weather data through computers.

For now, Mohart says, the results of the project are encouraging some neighboring growers to purchase weather stations for their own vineyards. It illustrates what Weigle knows is the surest way for an innovative practice to catch on—the success of a grower like Mohart.

Says Weigle: "We've found that if growers do it and go to the coffee shop and talk about it, it gets implemented much more quickly."

—*Susan Harlow*

If you grow vegetables, as Kenny Haines does on 90 acres near Belvidere, N.C., aphids are your enemy. If you're an aphid, ladybugs are your enemy.

It stands to reason then, that Haines would want to do anything he could to get the two insects together, especially since he's determined to hold on to the organic certification he was granted in 1989. For organic producers, synthetic pesticides aren't an option.

Haines had heard about businesses, most located in California, that specialize in the rearing and delivery of beneficial insects like ladybugs, but he'd also heard the frequent complaint that applications of bugs were temporary solutions at best. The bugs tended to clean a crop of its pests, then fly away in search of more. The next time a pest invasion took place, more bugs had to be ordered, and the process would begin anew.

In 1994, Haines discovered another alternative, almost by accident, that, nonetheless, is helping advance the science of integrated pest management (IPM) in North Carolina. He planted rye and vetch as a cover crop and windbreak, but soon realized an unexpected benefit.

"The following spring, I had a cover crop with a few aphids but massive amounts of ladybugs," he recalls. He mowed most of the covers to plant his vegetable cash crop, then found the ladybugs had migrated to the vegetables to eat aphids.

The ladybugs nested in the windbreak, which Haines had not yet mowed. "I'm not an entomologist, but it seemed to me those ladybugs then started mating, and gestating, and before long there were even more ladybugs," Haines says. "They stayed there all through the winter, too."

And that made them available, in much larger numbers, for pest control in Haines' 1995 crops.

By then, Haines—spurred by the excited urgings of

PLANTING A MIX OF RYE AND HAIRY VETCH AS A WINDBREAK ATTRACTED BENEFICIAL LADYBUGS TO KENNY HAINES' BELVIDERE, N.C., FARM. PHOTO BY ANDY CLARK.

entomologists from North Carolina State University—had applied for and received a producer grant from SARE to expand his use of cover crops and windbreaks. He wanted to see what kinds of insects various grain and leguminous cover crops would attract. He also wanted to experiment with retaining strips of cover crop within his fields of broccoli, cabbage, squash and cucumbers.

Haines' interest in a cover crop seeding operation isn't proprietary. Eventually, he hopes his efforts will lead to the establishment of an operation that can supply seeds for cover crop mixes based on the types of beneficial insects a farmer wants, to help further sustainable agriculture in North Carolina and beyond.

"I'm still learning every day about this," he says. "But what I think I've learned is that so many of us, so many times, have blinders on. For years, the entomologists only looked at bugs, while the plant biologist only looked at the plants and the soil engineers only looked at the condition of the soil.

"This kind of project helps emphasize how all of it works together and how important balance is."

And that's something he said he hadn't thought of in quite the same terms before, even though he's farmed for more than 20 years.

"The sad fact is that you're not encouraged to by the so-called 'experts.' More often than not, you get Extension people telling you how things can't be done that way."

KENNY HAINES HOPES TO ASSEMBLE A BASE OF KNOWLEDGE THAT WILL DEFINE THE MIXES OF FLOWERING, LEGUMINOUS AND GRAIN CROPS THAT ATTRACT AND RETAIN BENEFICIAL BUG POPULATIONS.

Haines said it takes "crazy people like me, who don't know any better," to shake things up every now and then to prove the experts wrong. And that's why he believes SARE grants are important.

"It gives people a chance to try out an idea. Then I can start telling people about what I've learned, and after a while someone from the university comes around and takes notice, and they say, 'Hey, this just may work.'"

That, Haines adds, is when things really start happening. He says he intends to continue his own on-farm experiments, showing his results to as many people as possible. His latest challenge is figuring out the attractive powers of flowering plants.

One of the cooperators in Haines' project is Michael Sligh, with the Rural Advancement Foundation. He believes the potential impact of Haines' work is "enormous." Sligh said that experimentation in California already had established a fair amount of data about what types of cover crops encourage beneficials, and how flowering and mowing patterns can encourage an influx of beneficials at just the right times to combat and control pests in that state's agricultural areas.

"What Kenny's doing is forming the seed of knowledge and experience necessary for making the same determinations about what will work for farmers in the coastal plains region," he says. "It's vital stuff. Once we learn it, it can lead to successful farming that doesn't use any chemical pesticides."

Sligh said he expects Haines to assemble a base of knowledge that experts can then augment. That base likely will better define the mixes of flowering, leguminous and grain crops that attract and retain beneficial bug populations sufficient to control pests not only on vegetables, but cotton, peanuts and other crops grown in the South.

"We've really just touched the tip of the iceberg with this kind of thing," adds Haines, who looks forward to the day when more integrated field work experimentation takes place between entomology and agriculture professionals. He hopes those professionals will view him as a resource.

Sligh says that attitude underscores for him the wisdom of SARE's decision to fund the project. "SARE is unique in the way it supports on-farm, farmer-led experimentation," he says. "Growers like Kenny Haines show how that can work to benefit all of us.

"If we had to wait for the official experts to look into these things," he adds, "we wouldn't know nearly what we know now."

—*David Mudd*

Oregon's normally lush Willamette Valley used to turn brown between fall's vegetable harvest and spring planting, a result of "clean" farming practices that left soil bare. Today, a drive through the agriculturally productive region in winter offers a much greener look.

"Fifteen years ago, I could tell what fields had been in corn or row crops because they were bare and brown," says Carl Hendricks, who grows sweet corn, snap beans, broccoli and other vegetables on 2,000 acres in the Willamette Valley. "There are still a few out there, but most fields now have cover crops. More and more growers are using them."

IN 1997, RESEARCHERS MEASURED BETTER CORN YIELDS AFTER PLANTING A WINTER COVER OF OATS, VETCH AND AUSTRIAN WINTER PEAS, THEN STRIP-TILLING SWEET CORN THE FOLLOWING SPRING.

Hendricks himself is a cover crops convert. For several years, he has worked with Oregon State University's John Luna, who received a SARE grant to test cover crop varieties and new tillage regimes to assess their potential to improve crop yields, beat weeds, lower input costs, reduce agricultural runoff and save farmers money.

In 1997, Hendricks measured better corn yields after planting a winter cover of oats, vetch and Austrian winter peas, then strip-tilling sweet corn the following spring. After killing the covers in the spring, he planted corn into eight-inch tilled strips amid the cover crop vegetative residue.

In the three fields enrolled in those trials, the strip-tillage system returned $100 per acre more than the standard tillage system. The returns resulted from increased yield as well as cost savings from reduced tillage.

"My normal practice is to plow the ground and work it all up, but I was looking for fewer trips over the field, which saves time and money," Hendricks says. "Strip-tilling was positive enough this year for me to definitely expand the trials next year."

Hendricks is one of several valley vegetable growers Luna and collaborator Dan McGrath work with to fine-tune their use of cover crops, typically planted to rebuild and protect the soil, not for harvest. Legumes, such as vetch, add nitrogen to the soil; grains, such as oats, capture excess nitrogen from a previous crop to guard against leaching into ground or surface waters. Luna's long-term project attempts to measure those and other potential environmental benefits against cover crop costs.

Luna collaborates with a group of farmers in the Willamette Valley, where wet springs and a strict planting schedule dictated by vegetable processing companies pose challenges to growers trying to incorporate a new crop into their rotations. To meet their critical planting dates for various vegetables between April and July, Luna has sought a combination of covers that can fix nitrogen and add organic matter but

STRIP-TILL, WHICH WORKS A NARROW BAND OF SOIL IN BETWEEN STRIPS OF RESIDUE, ATTRACTS BENEFICIAL INSECTS. PHOTO BY JOHN LUNA.

be killed in early spring.

"Cover crops keep the soil wetter in the spring, shading the soil so it doesn't evaporate, so it can work against farmers trying to meet a scheduled planting date," he says. "There comes the rub—they don't just plant when the weather is favorable."

Some of Luna's collaborating farmers have incorporated strip-till, which works a narrow band in between wider strips of residue-covered soil, to help address that problem. Strip-till puts only about 20 percent of the surface soil under tillage, helping address moisture concerns. Moreover, strip-tilling enables growers to prepare a seedbed in just one tractor pass, compared to five to 10 multiple passes under conventional conditions. Strip-till thus offers a dramatic savings in soil preparation costs.

On the Hendricks farm for example, tillage savings equalled about $30 per acre.

Luna suspects—and wants to prove—that increased organic matter and minimal soil disturbance also reduces soil compaction. "Maybe we are doing more harm by running many operations over that soil when it's not in ideal shape," Hendricks agrees.

Cover crops also provide habitat for insects that can prey on crop pests. Predator insects such as carabid beetles and spiders thrive in habitat left for them on the surface. Not tilling the ground keeps that habitat in place, a crucial consideration and an alternative to pesticides for Oregon growers trying to combat cutworm in corn.

Sampling in Hendricks' fields in 1997 found higher numbers of predacious carabid beetles in the strip-tillage blocks than in the conventional tillage blocks.

Luna stresses the need for continued research. After crop yields decreased following strip-tillage trials in 1996, Luna's experiments in 1997 incorporated at least a week-long delay between strip-tilling and planting. That extra week allows the soil to warm and provides time for the vetch and other legumes to begin releasing nitrogen.

Luna is encouraged by the prevalence of cover crop usage in the valley and the strong interest in strip-tillage systems.

"Many of our farmers are encouraged enough to expand the acreage in cover crops," he says. "They don't have much time in the spring, so if they can make one pass over the field rather than six or 10, that saves them time.

"We're pretty optimistic that we can really change the face of farming in the Willamette Valley."

Hendricks hopes cover crops will help his yields while protecting the soil from erosion. He also appreciates a more pleasing winter landscape.

"I use [covers] because I think we're doing the right thing for the soil," he says. "We're helping catch excess nitrogen in the fall, then putting nitrogen back into it. And I like the look of the field in the winter when there is something green out there." — *Valerie Berton*

Living near Bloomington, Ind., presented a golden opportunity for Jim Luzar as he evaluated the future of his family's 182-acre corn-and-soybean farm. Bloomington, he learned, was one of the best horticultural markets in the Midwest, close behind Madison in demand for organic products.

THE PROFESSIONAL DEVELOPMENT WORKSHOP DREW MORE THAN 50 EXTENSION EDUCATORS WHO WANTED TO LEARN ABOUT QUALITY OF LIFE-IMPROVING, SUSTAINABLE STRATEGIES FOR FAMILIES ON SMALL FARMS.

As a result of a real-life exercise conducted for a group of Indiana Extension agents, Luzar is poised to overhaul his central Indiana farm by growing organic vegetables and marketing them to Bloomington residents. The exercise, run by Craig Dobbins of Purdue University with Steve Bonney of the Indiana Sustainable Agriculture Association, among other cooperators, was part of a SARE-funded professional development project (PDP). PDP offers learning opportunities to a variety of agricultural Extension and other field agency personnel nationwide.

"I hadn't really perceived the marketing location as an advantage," says Luzar, who is also an Extension educator. Participating in a small-farm assessment — where Extension agents reviewed his farm goals and any constraints to achieving those goals — really opened his eyes.

"In Extension, I've been on the other side several times, but when you go through something like that yourself, you have a different outlook," he says. "It really illuminated different opportunities."

The Indiana project emulated a Missouri SARE PDP workshop held in conjunction with the 1996 Small Farm Today Conference and Trade Show held in Columbia, Mo. The PDP workshop drew more than 50 Extension educators from eight states who wanted to learn about quality of life-improving, sustainable strategies for families on small farms such as Jim Luzar's and were asked to recommend new, sustainable strategies.

In Luzar's case, he was looking to diversify. He considered livestock, but was drawn by the profit potential he saw in Bloomington for vegetables. An organic vegetable farm would have less impact on natural resources, and he wanted to involve a family member in the farm, an opportunity a horticultural operation could provide.

The Missouri case studies were based on similar, real-farm situations. Workshop organizers assigned eight such scenarios to Extension teams, aiming to raise their awareness of how many profitable, environmentally friendly and family-friendly options can exist on small farms.

"A farm is not just a production factory, it's a way of life, a place where families live and raise kids," says John Ikerd, an agricultural economist and coordinator of the PDP workshop. "We want Extension to look at the farm and the family as a whole and try to help people manage that whole to get a more desirable quality of life."

Farmers earning less than $50,000 in annual revenue per year constitute the majority of farmers, even though they produce far less than their larger, often corporately owned, counterparts. Strategies for small farmers abounded at the conference and the PDP workshop.

Nationally known small farm experts such as Joel Salatin from Virginia and Andy Lee from North Carolina presented information on market gardening and pasturing livestock, including hogs and poultry. Others offered information on controlling insects in vineyards using pheasants and incorporating poultry litter and other organic amendments into row-crop operations.

The Extension teams reported back to the PDP group with their findings and recommendations for the

SMALL FARMERS, SUCH AS THOSE RAISING HOGS ON PASTURE RATHER THAN IN CONFINEMENT, WANT MORE SUPPORT FROM EXTENSION AND OTHER AGRICULTURAL EDUCATORS. PHOTO BY JERRY DEWITT.

eight hypothetical farm case studies. Their presentations went over with a bang. Asked to evaluate the session, participants ranked the program 8.5 out of 10 for improving knowledge and 8.8 out of 10 for "usefulness." A full year later, participants filling out a post-conference survey were asked to evaluate the extent to which they had actually used what they had learned. They rated their "extent of use" at 7.76 on a scale of 1 to 10.

"It was a very positive response — they really took it seriously," Ikerd says.

Participants came from all over the North Central region. Bonney, president of the Indiana Sustainable Agriculture Association, found the seminar so useful he incorporated it into the PDP project in his state.

The program "addresses the concept of appropriate enterprises and complementary enterprises on a farm," says Bonney, who took Ikerd's approach one step further by taking the group of Extension professionals to Luzar's farm to help the owner to assess his goals. "Once on the farm, we see 'people issues' and 'money issues' that generally don't get into whole-farm planning, which usually starts and stops with conservation."

Shelly Gradwell, who works in the Iowa Extension system, found what she learned in Missouri "perfect" to meet the needs of small growers in Iowa. She gleaned information on community-supported agriculture (CSA) and direct marketing that she later published in a resource guide.

The 80-page guide has been distributed to about 100 growers requesting information about alternative strategies on small farms, fulfilling an obvious need in Iowa. In one year, the number of CSA farms in Iowa increased from four to 22.

"The speakers John [Ikerd] brought in were ideal to get resource information, tips and ideas for small-scale producers," Gradwell says. "It was exactly what I was looking for that wasn't available in Iowa."

The Missouri group aims to dispense information on small-farm opportunities to an Extension system that often compartmentalizes itself into a variety of specialty areas rather than looking at the whole-farm picture and a farm family's quality of life.

"The people we're trying to work with are those who see their primary roles as working with people, and their expertise is just one thing they're trying to provide," Ikerd says. "Right now, the number of agents who work that way are far smaller than the number of families who work that way."

For Luzar, the quality of life assessment may go far toward helping his family achieve its objectives.

"In the '80s, farmers only looked at the bottom line, worrying about profitability," he says. "As we looked at my family's objectives and values, we pretty much tabled that. If I go into marketing, I could work with people, meet new people, it would be environmentally friendly and have some real income potential." — *Valerie Berton*

As recently as 1994, many land grant universities and USDA agencies still considered sustainable agriculture a "fringe" concept advocated by organic producers and people who had little concern for the economic realities of farming. Since then, however, producers and the government agencies that serve and advise them have made significant progress in adopting and advocating sustainable agriculture practices and systems.

THE PROJECT WAS TO HELP CHANGE THE WAY THE FEDERAL AGENCIES THAT SERVE FARMERS LEARN ABOUT AND TEACH SUSTAINABLE AGRICULTURE.

It hasn't all been smooth sailing, says Kate Duesterberg, who coordinated a New England-wide SARE project to help change the way federal and state agencies that serve farmers learn about and teach sustainable agriculture.

Extension personnel, Duesterberg says, often were stuck in a traditional paradigm that kept them in the "expert" role. Their training and education led them to believe the answers to most, if not all, production problems could be found in university-based, scientific research, and their jobs were to mete out this information to farmers.

Duesterberg is among a growing group of people who believe sustainable agriculture requires a different kind of knowledge-building.

"We realized farmers themselves held a tremendous amount of knowledge about sustainable farming methods based on their own experiences," says Duesterberg, program coordinator for the Center for Sustainable Agriculture at the University of Vermont. "We knew we had to encourage agencies to engage in more participatory learning and teaching."

A project planning committee decided that, in addition to emphasizing sustainable production methods, they would figure out better ways of working with producers as co-learners and facilitators. As a result, they brought Extension and other agency field personnel to successful farm operations throughout New England. They also invited educators and producers to a region-wide conference and several sub-regional trainings, creating opportunities for them to learn from each other about holistic approaches to farm planning and decision-making.

One such method was developing "study circles" in which participants learn and discuss specific issues, striving to understand the values underlying all sides. At the conference, study circles served as the basis for discussing the complex and often emotional issues around sustainable agriculture.

Measuring gradual changes in attitudes, of course, is not as easy as counting new greenhouses or milking parlors. But Duesterberg says she can see progress over the three years of the project. For example, the 1997 New England Vegetable and Berry Conference included workshops devoted to organic production, integrated pest management practices and biological control. Eric Sideman, director of technical services for the Maine Organic Farmers and Growers Association, helped plan the conference—something he says he never would have been invited to do 10 years ago.

Sideman, who serves as a member of the New England PDP planning committee, also has noticed that Extension technical publications now include much more information on nonchemical pest control and advice for organic growers.

"Years ago, you would have just seen a list of registered pesticides," he says.

The number of Northeast farmers embracing management-intensive grazing has grown dramatically in the last few years, along with the number of certified organic dairy farmers. Most importantly, sustainability has become an integral goal for farms, rural communities and the agencies that serve them, Duesterberg says.

During four farm tours held in the region, agency staff visited farms practicing innovative and successful ways of growing and selling food.

The result of events like those are hard to quantify, admits Tim Griffin, sustainable agriculture specialist for University of Maine Extension and a member of the project's planning committee, but he thinks the benefit of working directly with farmers can only help.

On the tours, Griffin visited organic soybean operations and a northern New Hampshire farm where the farmer processes his own barley and soybeans. Some of what he picked up during the tours he was able to share later with Maine farmers, and believes that kind of information-sharing is one cause of greater soybean production in the state. The commodity jumped from 20 acres in 1996 to around 700 in 1997 as farmers learned to grow more of their own grain to feed livestock.

The PDP project also likely stimulated more on-farm research, as opposed to the old university-to-Extension-to-farm pipeline, Griffin says. More of his work now includes results from farm-based research.

"More farmers are saying to us, 'If you want to do research, you'll have to include us, because we're the ones the research is for,' " Griffin says. "That's just what we want them to say."

For some states, like tiny Rhode Island, which lacks resources for sustainable agriculture training, the opportunity to learn more was a boon.

"A couple of conferences I attended simply wouldn't have been a possibility for me without the SARE project," says Karen Menezes of the Rhode Island Center for Commercial Agriculture, also a key project planner.

The project has meant more than just dollars to Menezes. "It's been an open door for me to meet agriculturally connected people throughout New England," she says. "For the most part, if things don't happen right here, you don't hear about it. Now I'm in a better position to call, to ask for help for a problem we can't resolve here at the university."

Still in progress are a series of fact sheets that will explain the most current information for farmers seeking to learn about grazing watering systems, direct marketing, biological control in greenhouses and other issues.

"What we hope is not only to provide additional technical information, but to get people to think, to work closely with their communities to come to a more sustainable way of producing and distributing food," Duesterberg says. "It's our job to push people toward a new way of thinking." — *Susan Harlow*

MARJORIE MAJOR DEMONSTRATES HER CATTLE WATERING SYSTEM TO AGRICULTURAL EDUCATORS WHO VISITED HER GRAZING OPERATION IN HINESBURG, VT. PHOTO BY DEBRA HELEBA.

At first blush, the term management-intensive grazing can seem like a misnomer. Foraging animals led to grass will do what comes naturally, so where does management fit in?

There is a lot more to management-intensive grazing (MIG) than meets the eye, however. Farmers and ranchers need to learn how to raise forage for maximum nutrition for their livestock without overgrazing pastures, putting the need for proper management front and center, says Alan DeRamus, professor of agronomy and animal nutrition at the University of Southwestern Louisiana in Lafayette.

"We insist on using that term, instead of intensive rotational grazing," DeRamus says. "We want the emphasis to be on management. That's where the highest degree of success can be found."

DeRamus ought to know. With the help of a SARE professional development grant, he's put together an MIG program for Extension agents, Natural Resources Conservation Service (NRCS) field specialists and other educators.

One of the first such trainings below the Mason-Dixon Line is helping to kick off a quiet revolution in Southern cattle and dairy farming. Two Extension agents who attended DeRamus' program are adapting some of what they learned about MIG in farmer training sessions in Florida. One central Florida program recently drew about 200 ranchers.

The magic of MIG lies in the numbers, DeRamus says. For instance, he says it's pretty easy to prove, even to resistant farmers, that most Deep South pastures—with 30,000 to 50,000 pounds of beef per acre per day during the long growing season—will increase utilization of forage from 30 percent in conventional grazing to 70 percent in MIG.

"That means 30 to 50 cows per acre, and that was an unheard-of figure before intensive grazing came along," he says.

Producers need to keep

EXTENSION EDUCATORS EXAMINE A MIX OF FORAGES TO DETERMINE ITS NUTRITIVE VALUE FOR LIVESTOCK. SARE FILE PHOTO.

ONE OF THE FIRST MANAGEMENT-INTENSIVE GRAZING TRAININGS BELOW THE MASON-DIXON LINE IS HELPING TO KICK OFF A QUIET REVOLUTION IN SOUTHERN CATTLE AND DAIRY FARMING.

moving animals, leaving them in a pasture just long enough to eat the nutritious new growth, then removing them before they can damage the forage beyond the point at which it can regenerate. Sometimes that can mean turning a herd into a paddock for as little as an hour a day.

Talk about intensive management.

"It's all about knowing the kinds of forages you have on your farm, knowing what kinds you want, knowing your stock and what it likes to eat, knowing how many paddocks your pastures can be divided into, and managing resources like fencing and water availability," DeRamus says. "It's good management, pure and simple."

Trouble was, nobody was encouraging Deep South farmers how to think along those lines before DeRamus set up his training sessions. Amazed at how large cattle producers in Iowa and Missouri had reclaimed played-out pastures and increased their herd sizes, DeRamus wanted to see the system at work in his region.

"I thought surely we should be able to get even better results here in the South, with 55 to 90 inches of rainfall each year and a 300-day growing season," he says.

Survey results from the Midwest, where MIG has gained a following, cited farmers' lack of knowledge about proper grass farming as their primary reason for resisting adoption. Once Extension and NRCS personnel in those areas had gained enough expertise to pass on, many farmers chose to give it a try.

DeRamus figured the same would hold true for Louisiana, Mississippi and Florida. "Ranchers and farmers were looking for someone to consult with about everything they'd need to know to get started in MIG," he says. "The Extension Service and NRCS people were just behind the curve."

So he set out to educate the experts. The SARE grant helped him hire the staff necessary to put together a series of training seminars and workshops that started in 1995. The staff included a soils agronomist and economist, an NRCS range specialist, a local power-fencing expert and an instructor from the Noble Foundation, an organization devoted to cattle and grazing concerns. The grant also helped pay for ads in *Grassland Farmer* magazine announcing the series.

Those ads attracted the attention of David Solger, director of the Washington County, Fla., Extension Service. Solger, who works in Chipley, 50 miles north of Panama City, said he was overjoyed to learn of a MIG workshop taking place in the Florida Panhandle.

"I had been hearing a lot about management-intensive grazing," Solger says. "I knew of farmers in my area interested in it, but I needed to know a lot more myself before I could tell them whether it would work in Florida or not. When I heard about the program Alan put together, I didn't waste any time."

Solger said he "thoroughly enjoyed" the presentations and discussions on ruminant nutrition, nutrient cycling, the basics of forage growth, economics and strategies for year-round nutrition and fence-building at the workshop. The value of the information convinced him to plan his own workshop to take place in March 1998.

"You wouldn't believe the amount of interest there is around here," Solger says, referring to another participant in DeRamus' workshops whose MIG seminar in central Florida brought about 200 ranchers.

Solger remains frustrated by what he perceives as lingering resistance in Extension to embracing MIG, despite such "amazing" interest. "It may just be that people don't like to deal with anything new," he says. "It's just like a rancher who'll say, 'Well, that's the way my Daddy raised cattle and it's good enough for me, too.' "

Solger hopes training Extension and other ag educators in MIG will help change anti-sustainable agriculture mindsets. Grazing systems, which can work so well in cutting producer costs with much less environmental impact and potentially more time for family and community, should be a great place to start.

"What Alan does in his workshops—and what I intend to do in mine—is show farmers and ranchers why they've got to be grass farmers first, and then cattlemen," Solger says. "If they take care of that first part, the second part will just come naturally." —*David Mudd*

"BY GROWING OUR OWN FERTILIZER AND PESTICIDES, WE REDUCE — IF NOT ELIMINATE — THE NEED FOR COSTLY COMMERCIAL INPUTS, RESULTING IN A NET GAIN FOR THE FARMER."
— RAY MACDUFF

When a fruit and vegetable farmer in Guam asked Bob Barber, a University of Guam Extension economist, for help in assessing his operation's profit potential, Barber was happy to comply. He involved a group of Extension agents participating in a SARE-funded professional development project, getting their input in the budgeting process and, in turn, teaching them new ways of working with farmers.

The group helped farmer Bernard Watson — who, with 17 acres, is one of the largest fruit and vegetable producers on the small Pacific Island — analyze his costs and returns on one acre of papaya. They calculated labor, inputs and equipment against Watson's gross revenue and found he earns between $20,000 and $40,000 annually, depending on the presence of diseases or typhoons.

After assembling the data and developing a budget for Watson, the group later presented their findings at an annual Guam Small Business Conference.

"They were very interested in how to divide up production phases and how to actually interview farmers," says Barber, a co-collaborator on the SARE project led by former Hawaiian-based Extension educator Kathleen Delate. "They wanted to have budgets for the crops their constituencies are producing."

Information on assembling profitable budgets was just one part of a professional development project that extended beyond Guam to include Pacific Islands from Hawaii to Micronesia. The multi-year project covered livestock and aquaculture as well as agriculture unique to the islands — fruit plantations, market gardens growing taro and agroforestry operations centering on herbs like *kava kava* — with a sustainable twist.

The training, which took place between 1995 and 1997, represented some of the first lessons for Pacific Island Extension staff in how to help farmers raise profitable crops or livestock with minimal impact on their fragile, unique ecosystem.

"Overall, it's hard to farm in the Tropics because pests are present year round, soils are poor and there are steep slopes as well as typhoons and tropical storms," Delate says. "This group was committed to working together toward sustainability in the Pacific, which had never happened before."

After the training ended, many participants incorporated what they had learned into their day-to-day work, Delate says. Seven of the 20 agents held workshops on various sustainable agriculture practices, and several regularly used financial management data collection sheets Barber distributed to monitor farm costs or develop farm budgets in their districts.

While many producers on the smaller islands excluding Hawaii and Guam continue to practice what Delate calls "traditional" farming, more are beginning to join their larger neighbors in overusing synthetic pesticides and fertilizers. Instead, Delate and a team of Extension educators from the University of Hawaii, the University of Guam, the College of Micronesia, Northern Marianas College, American Samoa Community College and Palau Community College hope to turn the tide back and encourage farmers to adopt some of the sustainable methods their fathers and grandfathers practiced.

"Many older farmers have been practicing modified forms of sustainable farming practices all their lives," says Ray Macduff, who runs a crop demonstration farm in the Mariana Islands. "We are trying to modify these techniques into a more produc-

EXTENSION TRAINING IN THE PACIFIC ISLANDS INCLUDED A STOP AT A HAWAIIAN FARM GROWING TARO, A POTATO-LIKE ISLAND STAPLE. PHOTO BY JERRY DEWITT.

tive commercial system."

Farmers struggling on tiny parcels plagued by tropical weather and diseases need alternatives to the prohibitive cost of importing fertilizers and pesticides from the U.S. mainland. One low-cost technique is to apply more local inputs like tree prunings and manure compost to amend the coral, very alkaline soils.

Most of the training took place outdoors, where a group of about 20 Extension agents and Natural Resources Conservation Service representatives saw firsthand how an organic market garden, Watson's fruit plantation, aquaculture, agroforestry operations and the Marianas demonstration farm can reduce inputs.

In Hawaii, for instance, the group learned how a taro farmer applied composted hog manure from a nearby hoop house mixed with macadamia nut shells to meet all his fertility needs. Taro, a potato-like root, remains a major food source in the Pacific Islands. On the Hawaiian island of Kauai, the group learned about biologically based pest management of herb, vegetable and fruit pests.

In Pohnpei, participants got their hands dirty. Extension educator Jackson Phillip led the participants in planting *kava kava* in a lowland forest as part of a farm demonstrating appropriate species for the ecosystem.

On Guam, agents working with Extension horticulturist Frank Cruz measured the presence of nitrates, a soluble form of nitrogen that can contaminate ground and surface water, on a tropical fruit and vegetable farm. After agents collected leaves and extracted sap to run through portable test kits, they found the farmer did not need to apply as much fertilizer. The finding helped convince the farmer to reduce his number of fertilizer applications, Cruz said.

The group also toured an aquaculture demonstration site "designed to tolerate the harsh salt environment of the islands while keeping the set-up expenses and labor to a minimum," says David Crisostomo, a Guam Extension educator.

The demonstration featured tilapia and ornamental fish such as swordtails swimming in a 12-foot pool whose filtering system contains many locally available materials such as plastic ring tops used in drink six-packs. Such recirculating aquaculture systems meet new regulations governing the release of effluent to prevent the introduction of exotic species into Pacific Island watersheds. Discharge water from the demonstration system was recycled as irrigation and fertilizer in garden plots.

Aquaculture can bring hefty returns. Raising fish at the demonstration site cost between $1.50 and $1.75 a pound, while the average selling price for tilapia in Guam runs about $2.50 a pound. In the last year, Crisostomo reports about 10 new aquaculture operations in Guam alone.

"The importance of sustainable agriculture in the Pacific can be summed up by the bottom line," Macduff says. "By growing our own fertilizer and pesticides, we reduce—if not eliminate—the need for costly commercial inputs, resulting in a net gain for the farmer."

—*Valerie Berton*

When he heard about a neighbor's plans to build a new house abutting his farm's "back 40," Amish farmer Leroy Kuhns underwent some real soul-searching. He loved the view of the eastern Ohio woods his back field provided and the quiet respite from his daily labors. The prospect of a new house alarmed him enough to make him consider uprooting his family from their Amish homestead.

In the end, Kuhns decided he would have to live with the new house encroaching on his property. The land where he lived and worked had been "too good to him" for him to leave it, privacy or no privacy.

The house was never built. But the anecdote illustrates the tie most Amish farmers feel to the land that sustains them. Kuhns and other Amish farmers "have a sense of connection with their place and the land that supports them that really seems to be an ingredient in sustainability," says Deborah Stinner, an Ohio State University researcher studying the Amish community.

Under the auspices of a SARE grant, Stinner and colleague Richard Moore are analyzing the farming systems of the Holmes County Amish—the world's largest such group—to find concepts and practices relevant to mainstream farmers. The holistic view incorporated by Amish farmers include economic well-being, use of environmentally sound farming practices and, above all, a healthy, happy and productive quality of life that integrates family and community.

"We want to find out what we can learn that might help others not of this culture," says Stinner, an agro-ecologist who has worked with Amish families since the mid-1980s. "In many ways, these people are living as our ancestors lived by fostering community cooperation, which we left behind as we moved into more industrialized agriculture. This is an opportunity to look back and evaluate how sustainable that is."

Stinner and Moore have homed in on three Amish farms that, typically, integrate a mixture of crops with a dairy operation. The largest field is 12 acres, the smallest, contour strips of 1.5 acres. The researchers have immersed themselves in the Amish farming life, working alongside the men and women to pick up clues to the farms' successes.

Already, the study has turned up some intriguing lessons for farmers seeking to make their operations more sustainable. Economic studies indicate high levels of efficiency for the Amish farms. The three Amish families kept an average of 47 percent of their gross income as profit over the two years of the study, compared to 23 percent for a group of five non-Amish grazing dairies with herds ranging from 39 to 175 cows.

THE THREE AMISH FAMILIES KEPT AN AVERAGE OF 47 PERCENT OF THEIR GROSS INCOME AS PROFIT OVER THE TWO YEARS OF THE STUDY, COMPARED TO 23 PERCENT FOR A GROUP OF FIVE NON-AMISH GRAZING DAIRIES.

The Amish farmers use low levels of purchased fertilizer, yet regularly test at desirable soil fertility levels. Finally, a shared labor ethic among Amish farmers creates strong bonds between extended families, church groups and community lines drawn along physical boundaries such as watersheds.

The Klein family, for example, milks 27 cows, yet produces as much profit as a 150-cow operation in an average year by processing and selling cheese. The Kleins use just the herbicide atrazine in their corn crop, with no purchased fertilizers, yet produce yields that shocked the research team.

"The families we're working with have small herds, but make as much money in some years as non-Amish farmers milking large herds," Stinner says. "These are very important results; it tells us there can be real efficiency in the smaller scale."

The Amish retain a sense of closeness to the land that begins in childhood. Schoolchildren recite butterfly names as easily as the alpha-

RESEARCHERS STUDYING AMISH FARMERS IN OHIO POINT TO THEIR FARM DIVERSITY AS A KEY FACTOR IN THEIR ECONOMIC SUCCESS. PHOTO BY RICHARD MOORE.

bet. As farmers, the Amish divide their land into "environmental zones" to manage the plots as natural resources and soil types dictate. A study analyzing the ratio of applied purchased fertilizer to chemical runoff showed all three farms are close to a balance, operating at high levels of nutrient efficiency. The farmers also try to retain land best suited for wildlife.

"To be on one of the farms in the middle of the summer is to see the number of species that really exist out there in nature," says Moore, an anthropologist. "Their farms are not dull, dry places."

Extended families, which usually live together, share the farm work. Most families plant crops to guarantee an even work flow throughout the year, such as following field corn with sweet corn to prolong the harvest season.

What really sets Amish farming communities apart is how neighbors will pitch in as needed to get a job done.

To keep farms viable across generational lines, most Amish designate a single heir to inherit the operation. This approach retains full-size farms, even though it singles out one child to carry on the tradition. Farm transfers generally are handled within a family with trust and love, Moore says.

"Quality of life is based on the values of a community," he says. "In their case, they balance community and family and the economic situation within the family. They are successful at transferring farms because they think through how changing the size of the farm will impact that transfer."

Interest in the project abounds. The United Nations invited Stinner and Moore to contribute a piece about Amish sustainability for a book on biodiversity, and the team is considering writing a book on Amish agriculture.

In the meantime, they hope the study will encourage people to think about how they might create a more integrated system on their farms and ranches. "These are not low-production farms," Stinner says. "But they work much more within nature's ecological principles and practices."

— *Valerie Berton*

The last decade has seen phenomenal growth in Vermont's organic dairy farming industry. The timing couldn't have been better for Enid Wonnacott of the Northeast Organic Farming Association of Vermont to help farmers who wanted to convert to a system that could offer profits while reducing impacts on the environment.

THE NET FARM PROFIT FOR DAIRY PRODUCERS ANNIE CLAGHORN AND CAITLIN FOX CLIMBED 40 PERCENT OVER THE THREE YEARS OF THE SARE PROJECT AS THEY IMPROVED THEIR MANAGEMENT AND REDUCED EXPENSES.

So little research had gone into organic dairying and the industry was so new, farmers who wanted to convert to organic had many questions.

"I could see it coming, and could see that [farmers] needed answers," Wonnacott says. "No one had put funding into any of the questions on organic dairying before. Organic has changed the way people think about farming.

"Conventional farming in general says, 'There's a problem; let's fix it.' But there is no quick fix."

Instead of providing just hard-and-fast data, Wonnacott wanted to convince each farmer to develop his or her own solution to the most perplexing problem on the farm.

When she and her collaborators began their research in 1993, with the help of a SARE grant, there were only four certified organic dairy farmers in Vermont. Just five years later, largely due to the start-up of The Organic Cow, a successful organic dairy processor, there were 40 certified organic dairy farms in the state. They earn more than $18 for 100 pounds of milk, nearly $6 more than for conventionally produced milk.

As a result of some of that research, Wonnacott and her team have helped participating dairy producers lower their costs and improve their profits. A primary project recommendation that organic dairy farmers use intensive pasture management to grow and utilize more high-quality forage helped several Vermont farm families.

At Taconic End Farm in Brandon, the net farm profit for Annie Claghorn and Caitlin Fox climbed 40 percent over the three years of the project as they improved their management and reduced expenses. For long-time organic farmers Nancy Everhart and her husband, Peter Young, of Plainfield, the cost of producing milk dropped by $5,000 over the three years.

Those impressive findings came from a project that features case studies of four organic dairy farms, three farms in transition to organic and one conventional dairy. Wonnacott used a systems approach because farms differ markedly from one another and because production factors are so interrelated. Thinking about those factors as discrete components doesn't work for organic dairying, she says.

Because the project emphasized getting information out to the farmers, many others benefited as on-farm technical meetings were opened up to anyone. A wave of soon-to-be-organic farmers, eager to ship milk to The Organic Cow and hungry for knowledge, flocked to the meetings.

"What was as beneficial as anything else was the networking and to get farmers talking and helping each other," Wonnacott says.

Researchers gathered three years of data on everything from economics to milk quality to herd health, allowing them to get off the univer-

A DAIRY PRODUCER WHO REPLACED INSECTICIDES WITH BENEFICIAL PREDATORS DRAMATICALLY CUT BACK ON FACE FLIES. PHOTO BY VALERIE BENTON.

sity campus and into the fields to work more closely with the farmers. Both the researchers and farmers enjoyed the collaboration.

"One of the best things about it was that it allowed us as a farm to tap into the empirical resources of the university—soil testing and feed testing," says Jack Lazor of Westfield, Vt.

As part of the SARE study, Dr. Joseph "Woody" Pankey of the University of Vermont Quality Mile Research Lab examined how organic practices affected the incidence of mastitis, an infection of the udder. Most organic livestock farmers use homeopathy, a system of medicine that uses plant-derived natural substances to strengthen and stimulate an animal's immune system. He found that treating mastitis homeopathically cost between $1 and $2 per cow, far less than conventional antibiotics.

Many of the farmers adopted new practices based on information they gleaned during the project. For instance, the Lazors, the first organic dairy farmers in Vermont, learned they could grow all their own grains more profitably than purchasing feed. Another farm dramatically cut back on face flies after switching from synthetic insecticides to natural alternatives such as beneficial predators and parasite-munching poultry.

Eric Clifford of Starksboro, the study's conventional farmer, discovered a nosode—a homeopathic approach—could successfully treat hairy heel wart and calf scours. Vince Foy and Debbie Yonkers of North Danville stopped using synthetic herbicides on their corn and cultivated for weed control, as they transitioned to organic in 1995. They also replaced chemical fertilizers with organic fertilizers, manure and green manure crops.

Foy has contracted with a conventional farmer to grow their organic high-moisture corn. "It's made it possible for me to encourage a conventional farmer and pass information along to him," Foy says. "Because it's a local supply, it keeps the money in a smaller area, cuts out the middleman and makes it more profitable for us."

Quantifying the social effects of organic dairying must still be gleaned from the project data; pinpointing environmental effects will be harder yet. But one of the important results of the study has been to prove that soil fertility can be maintained with manure, crop rotation and natural soil amendments, Wonnacott says.

Converting their 70-head Jersey farm to organic, although it decreased milk production by 10 to 15 percent, increased Foy and Yonkers' gross income from $125,000 to $165,000, and cut their debt to cow ratio in half.

"It's not just Easy Street," admits Foy. "It's tough, dealing with people who don't understand organic and don't believe what you're doing is viable. But overall, the business has done much better. The telling thing will be in 20 years: If our business is still here, it will sink in with people." — *Susan Harlow*

INTEGRATED FARM/RANCH SYSTEM

One of the oldest waterways in the world, the New River has become the focus of intense interest among mid-Atlantic environmental groups, politicians, researchers and residents in recent years.

Fewer resulting "downstream" impacts from growing a mix of grass and legumes instead of row-cropped grain for animal feed is but one environmental benefit of grazing systems over raising grain crops and feeding cattle in confinement. Grazing systems also can reduce erosion, provide more wildlife habitat and utilize fewer purchased inputs such as pesticides and fertilizer.

Measuring a grazing system's impact on nutrient loading in a New River tributary was but one part of a multi-year, multi-faceted project conducted by a group of SARE-funded researchers at Virginia Tech. Researchers also wanted to determine if such systems are profitable.

In order to test whether management-intensive grazing systems can produce cattle of equal weight and grade to conventional livestock systems that rely on supplemental feed, the Virginia Tech group compared integrated crop/livestock systems they labeled "sustainable" and "conventional."

Data from four years of experiments showed better weight gains for steers raised within a sustainable system that included well-managed grazing integrated with low-input crop systems. The jump in weight gains

RESEARCHERS JOSEPH FONTENOT AND RACHAEL SHANKLIN EXAMINE CATTLE RAISED ON ALFALFA AND CORN IN THE PROJECT'S "SUSTAINABLE" SYSTEM. PHOTO COURTESY OF VIRGINIA TECH.

STREAM BANK EROSION WAS REDUCED BY 77 PERCENT, AND CONCENTRATIONS OF SUSPENDED SOLIDS, NITROGEN AND PHOSPHORUS WERE REDUCED BY 90 PERCENT, 54 PERCENT AND 81 PERCENT, RESPECTIVELY.

corresponded with management improvements, such as portable fences, which allowed researchers to move the steers within the system to feed on high-quality forages in both pasture and a crop field designed for grazing. The cattle grazed annual crops such as rye and a fescue-alfalfa mix.

The sustainable system would save producers money in input costs by reducing the need for purchased fertilizers and pesticides. Overall, however, costs and returns between the two systems came out about equal because of the need to run extra machinery in the sustainable system.

"There is little difference in the returns, but the sustainable system cut input costs," says Joseph Fontenot, a Virginia Tech researcher. "We never really thought the sustainable system would increase profits, but we wanted to at least maintain animal productivity and cut down chemicals such as nitrogen and pesticides."

The project, which began in 1992, compares 48 steers per year and 80 acres of crop and pasture land. In the conventional system, researchers grazed Angus cattle on fescue and red clover and raised corn for silage and alfalfa for hay. The steers were finished in a feedlot. The conventional system was set up under "best management practice" guidelines recommended by the Cooperative Extension Service and utilized by many Virginia farmers.

The sustainable system built in more flexibility because it used crops for the steers to graze as well as a pasture of fescue and alfalfa. The crops — corn, wheat, millet, alfalfa and rye — were grown using rotations. The system incorporated winter cover crops, conservation tillage and integrated pest management. The Angus steers grazed stockpiled fescue/alfalfa, plus hay in the winter, and were let into the cropping system to graze wheat or millet when available.

The project's sustainable system used fewer agrichemicals. Researchers found the system cut pesticides from 23 different applications in the conventional to 14 in the sustainable system. The crops portion of the project compared a conventional 10-year rotation — corn for five years followed by alfalfa for five — with a four-year system including corn, wheat, millet, alfalfa and rye. The sustainable system produced more total forage in alfalfa hay and used far fewer insecticides and herbicides. Nitrogen fertilizer needs in the sustainable cropping system were reduced because alfalfa, a legume, helps fix nitrogen in the soil.

Encouraging the cattle to harvest their own feed, whether in pasture or off crops, would help farmers and ranchers avoid the time and expense of harvesting their own grain. Many graziers have spoken of a better quality of life associated with less time in the fields.

"In the other system, we have to feed them fescue until it runs out," Fontenot says. "A typical farmer would have to buy hay to supplement. The sustainable system gives a lot of options."

In an effort to minimize animal agriculture's impact on the New River watershed, the researchers evaluated ways to discourage grazing cattle from entering a New River tributary. As part of the complex project that quantified the myriad benefits of grazing systems compared to conventional livestock systems, researchers homed in on River Ridge Farm on the banks of the New River to test a cattle watering system that could attract grazing cattle — which naturally seek cool streams during summer — away from the river.

Virginia Tech's Ron Sheffield, David Vaughan, Saied Mostaghimi and Viven Allen, now with Texas Tech, set up spring-fed watering troughs in strategic areas in the pasture. They wanted to see if they could keep cattle — and their manure, which contains nitrogen and phosphorus — out of the river without using expensive fencing. The group measured nitrogen and phosphorus in the stream after cattle drank from it, then compared it to a later measurement taken after the livestock were given a choice of drinking from the troughs.

The impact, Allen says, was dramatic. "The cattle clearly preferred to go to the troughs, and we saw much decreased nutrient loading and sedimentation in the stream," she says.

Stream bank erosion was reduced by 77 percent after they installed the alternative water source, and concentrations of suspended solids, nitrogen and phosphorus were reduced by 90 percent, 54 percent and 81 percent, respectively.

— *Valerie Berton*

In a small fruit orchard like Bill Howell's, time is of the essence. Holding down an off-farm job, raising a family and managing an eight-acre stone fruit orchard makes it imperative for Howell to manage his time wisely.

That's why when Washington State University researcher Linda Hardesty came to him with a novel idea to save time managing vegetation in his cherry and plum orchards, he was more than willing to give it a try.

Hardesty, a WSU ecologist, had spent four years working in a Brazil sheep and goat research center. Intrigued by the common Brazilian practice of introducing sheep into fruit orchards to graze tree understories, she began speculating about how U.S. orchardists could integrate livestock into their fruit operations. The sheep grazed unwanted vegetation below and between trees, eliminating the need for chemical weed control.

"We have our land so separated, we don't look at multiple uses or complementary uses of the same parcel of land," says Hardesty, who obtained a SARE grant to test the potential of sheep to manage vegetation in Washington and Idaho fruit orchards.

"Ecologists look at the flow of energy through a system — from sunlight, to trees, to foliage, to animals, to people. In our agricultural systems, we focus on energy going into a particular product, and anything else is considered waste."

Hardesty wanted to test how to convert the "waste" under fruit trees that orchardists commonly control with herbicides to sheep forage. She hoped to discover if the practice would save farmers money and protect natural resources by reducing or eliminating herbicides and cutting fossil fuel used in multiple tractor passes.

After initial rebuffs when

SHEEP INTRODUCED INTO STONE FRUIT ORCHARDS DID A THOROUGH JOB OF CLEANING TREE UNDERSTORIES, REDUCING THE NEED TO MOW AND SPRAY HERBICIDES. PHOTO COURTESY OF WESTERN REGION SARE.

she sought potential cooperators, Hardesty connected with Howell. Howell not only grows cherries and plums on eight acres in Washington's Yakima River Valley, but he also raises sheep.

Perhaps most important, Howell was interested in ways to reduce his time in the field.

"In a small orchard like mine, an awful lot of the inputs are my own time," Howell says. "The time constraints of mowing and herbicide application were the major reasons for my wanting to look at sheep to do the job when I'm not around."

An economic analysis undertaken at the end of Hardesty's trial found that when orchardists used sheep—either raising livestock yearround or buying and selling feeder sheep each season—to manage vegetation, they realized greater profits. When lamb prices equaled at least $1.05 per pound, and with labor priced at $8 an hour, the sheep system proved more profitable than traditional orchard management.

Thick tree understories can hamper fruit production, partly because they provide shelter for rodents that eat fruit and damage trees. Creating an integrated farming system utilizing both sheep and fruit could allow Howell to increase his flock and take advantage of good wool prices while also boosting tree health in the orchard.

"WE HAVE OUR LAND SO SEPARATED, WE DON'T LOOK AT MULTIPLE USES OR COMPLEMENTARY USES OF THE SAME PARCEL OF LAND." —LINDA HARDESTY

Hardesty introduced sheep into test plots on Howell's four-acre sweet cherry orchard. At any given time, she would allow up to 20 sheep in the orchard. She studied what forage was available in cherry tree understories and measured the amount the sheep consumed. She compared those figures to control plots of ungrazed trees to determine the amount the animals were grazing over five years. She also ran a similar study at a one-acre mixed fruit orchard in Latah County, Idaho.

At both sites, Hardesty found the sheep did a thorough job of cleaning orchard tree understories, reducing the need to mow and spray herbicides. The practice significantly reduced input costs while providing an additional source of revenue.

"I reduced the number of times I mowed the orchard by 100 percent," Howell says. "I used to mow six times a year, and then I didn't mow at all."

The system was not without pitfalls, however. In addition to grazing the understories, the sheep were attracted to the succulent cherry leaves hanging overhead.

Although Hardesty and Howell tried to train the animals to leave the foliage alone—consulting with animal trainers and applying bad-tasting, non-toxic sprays to the leaves—the best solution only worked for six weeks.

"It's like having a kid in a candy store. There are too many good things close to them," says Howell, who has reduced his animals' time in the orchard because of the damage.

Adding livestock to the fruit system also required some time management and know-how many orchardists do not have. Howell moved the animals from the orchard each time he sprayed insecticides, about three times a season. The animals grazed in an adjacent pasture until re-entry after spraying was considered safe.

"Because cherries are harvested in June, everything goes on from April to July," Hardesty says. "Farmers are in and out, continually managing the orchard. In this system, you're moving animals back and forth a lot."

Other producers attending field days and other presentations have since adopted the integrated system idea, Hardesty says, although none use livestock in orchards full time.

Howell continues to use sheep part time to clean up the foliage that falls each autumn. But until he learns a way to entice them away from the trees themselves, he hesitates to incorporate them full time.

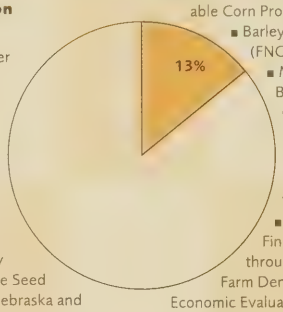
"Until you can train animals not to eat a particular piece of vegetation in an orchard setting, I don't think it will be completely utilized," says Howell, who longs to increase his flock size. "I'd have more wool and meat, along with the cherries, plus the economic benefit of losing input costs. Anytime someone says he knows how to train sheep, I perk up."— *Valerie Berton*

SARE PROJECTS, 1988-1997

To obtain information about a SARE project, note the project number in parentheses, then contact the appropriate regional office on page 96. Or access project information on the World Wide Web. See page 96 for SARE's web address.

CROP PRODUCTION PROJECTS

North Central Region



1997

- Using Small Grain Cover Crop Alternatives to Diversify Crop Rotations (LNC97-116)
- Farmer-Designed Research on the Use of Legumes in Sustainable Dryland Cropping Systems (LNC97-104)
- Kentucky Blue Grass Management and Variety Evaluation for Sustainable Seed Production in Western Nebraska and Surrounding Area (FNC97-200)
- Long-Term Benefits of Cover Crops and Crop Rotations (FNC97-196)
- The Economics of Seed Saving on Three Biological Farms in Western Michigan (FNC97-189)
- Trees for Food (FNC97-184)
- Comparing Controlled Microbial Systems (CMS) Composting to Conventional Composting to Piled Feedlot Manure (FNC97-181)
- Converting Unproductive Woodlands Into a Profitable Shade-Plant Nursery (FNC97-175)
- Feasibility of Corn Stalk Ash as a Fertilizer Source (FNC97-173)
- Innovative Farmers Seeking Lowest Nitrogen Rates for Corn on Sandy Soils to Protect Ground Water (FNC97-166)

1996

- Using Forages and Grazing Systems as an Alternative to Crop Production on Michigan Muck Soils (FNC96-155)
- Cover Crop Inter-Row Seeder for Row Crops (FNC96-153)
- Comprehensive Integrated Agroforestry Project (FNC96-148)
- Multiple-Site Evaluation of Cover Crops Established in Wheat Stubble (FNC96-136)
- Corn Starch Amendment for Marginal Soils (FNC96-133)

1995

- Reduced Chemical Inputs in Alternative Potato Farming Systems (LNC95-86)
- The Effect of Spring Seeded Annual Medic genus Medicago, on Weed Management and Soil Quality in Corn Production (LNC95-79)
- Implementing Sustainable and Organic Practices Using Rotary Tillage and No-Till Equipment to Farm in 30' Strips that Will Meet ASCS Erosion Mandates (FNC95-99)
- Living Mulches in Minnesota Wheat (FNC95-91)
- Interseeding Field Peas and Yellow Mustard for Enhanced Moisture Retention and Harvesting Ease in a No-Till Cropping System (FNC95-90)
- Identifying Management Practices that Enhance the Probability of Producing Quality Durum Wheat for Pasta (FNC95-128)
- Improving Ground and Surface Water Quality by Reducing Commercial Fertilizer Applications to Fields Receiving Livestock Manure Applications (FNC95-125)
- Cover Crop Management in the Upper Midwest (FNC95-117)
- Nitrogen Management on Sandy Soils for Environmentally and Economically Sustainable Corn Production (FNC95-113)
- Barley Breeding by the Public (FNC95-111)
- Measuring Nitrogen Benefits of a Hairy Vetch Cover Crop for Corn Production and Evaluating a Portable Soil Nitrate Test Kit (FNC95-108)

1994

- Sustaining Row Crop and Fine Hardwood Productivity through Alley Cropping: On-Farm Demonstration, Research, and Economic Evaluation of an Integrated System (LNC94-72)
- Economic and Ecological Analyses of Farms and their Component Practices to Promote Crop Rotation and Cover Crop Systems (LNC94-70)
- Integrated System for Sustainability of High Value Field Crops (LNC94-64)
- Hairy Vetch in Minimum-Till Organic Rotation (FNC94-87)
- Strip Cropping in a Four-Crop Rotation (FNC94-63)
- Continuing Study Relating Potassium Uptake to Manure and Tillage (FNC94-60)

1993

- Annual Medics: New Legumes for Sustainable Farming Systems in the Midwest (LNC93-58)
- Soil Conservation and Residue Management Demonstration (FNC93-52)
- Producing and Processing Sweet Sorghum in the Upper Midwest (FNC93-46)
- Comparing Composted and Raw Manure in Crop Production (FNC93-45)
- Clear Hilum Organic Soybean Trials (FNC93-41)
- Potassium Uptake in Relation to Manure Application and Tillage Practices (FNC93-39)
- Utilizing a Portable Scale to Evaluate Crop and Livestock Production (FNC93-31)
- Winter Rye as Companion Crop in Establishment of Alfalfa (FNC93-29)
- No-Tilling Hairy Vetch into Crop Stubble and CRP Acres (FNC93-28)

1992

- Contour Strip Intercropping and Rotations to Reduce Soil Erosion and Energy Costs in Production Systems (LNC92-46)
- On-Farm Research and Demonstration of Ridge Tillage for Sustainable Agriculture (LNC92-44)
- Development of a Sustainable Crop Rotation System (FNC92-25)
- Strip Tilling Sunflowers into Small Grain Residue (FNC92-16)
- Weed Control in Sugar Beet Production Utilizing Ridge Tillage and Cover Crops (FNC92-13)
- Converting Windrower into an Efficient, Affordable Compost Turner (FNC92-09)
- Annual Alfalfa and Berseem Clover Interseeded into Winter Wheat for Fall Grazing and Green Manure (FNC92-04)
- Comparing Various Rates and Application Methods of Liquid Swine Manure in Grain Sorghum Production (FNC92-03)
- Evaluation of Ridge Tiling with and without Herbicides (FNC92-02)
- Evaluation of Various Legumes for Use as Green Manure Cover Crops (FNC92-01)

1991

- Legume Management Research for VA Mycorrhizal Enhancement in Potato Production (LNC91-41)
- Improving the Ecology of Corn Production and Testing Perennial Alternatives to Silage Corn (LNC91-35)
- Strip Cropping Systems to Reduce Energy Inputs and Optimize Profitability (LNC91-34)

1989

- Synchrony and Contribution of Legume Nitrogen for Grain Production Under Different Tillage Systems (LNC89-25)

Crop Rotation, Legume Intercropping and Cultural Pest Control as Substitutes for Purchased Inputs in a Cash Grain Cropping System (LNC89-24)

1988

- Effect of Tillage and Weed Control Alternatives on Crop Rotations (LNC88-17)

A Research/Extension Awareness Program for Low-Input Agriculture in Ohio (LNC88-15)

- Substituting Legumes For Fallow in U.S. Great Plains Wheat Production (LNC88-10)
- Agronomic and Economic Analyses of Alternative Small Grain/Row Crop Production Systems for the Northern Plains (LNC88-09)
- Development of Organic Nitrogen Availability Functions for a Nitrogen Management Model (LNC88-06)
- Low-Input Ridge Tillage System for the Corn Belt (LNC88-03)
- Integration of Conservation Tillage, Animal Manures, and Cultural Pest Control in Corn (LNC88-01)

Northeast Region

1997

- Sustainable Phosphorous Fertilizer Recommendations for Corn Production in the Northeast USA (LNE97-93)
- Demonstration of Narrow Row Corn Production in New York (LNE97-91)
- Nutrient Retention and Humus Formation in Various Bedding Materials (FNE97-186)
- Diversifying an Organic Grain System: Spring Wheat & Edible Bean Variety Trials (FNE97-185)
- Cover Crop Interseeding into Soybeans at Time of Last Cultivation: Adapting Experimental Results into Practical, Farm-Scale Methods (FNE97-179)
- Comparison of Weed control and Soil Erosion Control in 15" row Corn vs 30" row Corn (FNE97-170)
- Evaluating Forage Quality and Yield in Pastures in the Shenandoah Valley (FNE97-168)
- Covercropping Strategies for the Intercropping of Clovers with Corn and Cereal Crops (FNE95-95)
- Sorghum Syrup Production in Vermont (FNE95-114)

1996

- Seed Saving and Biodiversity in the Northeastern United States (LNE96-78)
- Growing Potatoes Organically 3 Different Ways (FNE96-154)
- Economical Analysis of Kenaf Grown with Different Nutrient Sources (FNE96-147)
- An Evaluation of Chinese Medicinal Herbs as Field Crops in the Northeast (FNE96-144)
- Economic Comparison & Weed Control Observation of 15" Row Corn vs. 30" Row Corn (FNE96-128)
- Improving Potato Seed Performance (FNE96-123)
- Feasibility of No-till Frost Seeding (FNE96-116)

1994

- Development of Sustainable Cropping Systems for New York Cash Crop Producers (LNE94-51/ANE92-08)
- Sorghum/Soybean Forage Mixture—Is it a good alternative to corn silage for the Northeast? (FNE94-60)
- Community Supported Composting (FNE94-58)
- Innovative Uses of Leaf Compost for the Modern Farmer/Grower (FNE94-48)

1993

- An Integrated Extension/Research Program for Replacing Herbicides with Mechanical Cultivation in New York State (LNE93-34)
- Integrating Stewardship Forestry into Total Farm Management (LNE93-37)
- Increasing Options for Cover Cropping in the Northeast (FNE93-14)
- Evaluation of a Fiber Flax Production System as a Low Input, Alternative Crop for Northern New England (FNE93-11)
- Nutrient Management for Potatoes Used for Potato Chips (FNE93-10)
- Development and Evaluation of an Alternative Ice House Refrigeration System (FNE93-06)

1991

- Use of the Pasture Disk Meter to Promote Wider Use of Conservation Winter Covers by Providing a Rapid Method of Accurately Measuring Winter Legume Nitrogen (ANE91-03)
- Improving Crop Adaptation to Alternative Systems (ANE91-01/LNE91-25)

1990

- Sustainable SOD Production for the Northeast (LNE90-24)

1988

- Alternative Cropping Systems for Low-Input Agriculture in the Northeast (LNE88-09)
- Accelerating the Adoption of Low-Input Sustainable Systems for Field Crops (LNE88-04)

Southern Region

1997

- Sustainable Wheat Management Systems (FS97-63)
- Maximizing Corn Production through Tillage Methods, Cultivar and Fertilization in the Mountains of Southeast Kentucky (FS97-62)
- Effects of Conservation Tillage on Water Quality in Southern Texas (FS97-50)

1996

- Alternatives to Chemicals in the Peanut Cotton Rotation (FS96-44)
- The Production of Bromus Willdenowii Kunth Prairie Grass (Grasslands Matua) and Bromus Stamineus Desv. Grazing Brome (Grassland Gala) in the Tennessee Valley as an Alternative to Fescue and Ryegrass (FS96-41)

1994

- Clover Cover Crops, Weed Management and Consumer Tolerance to Insect Damage (FS94-16)
- Site-Specific Applications of Seed/Fertilizer/ Chemicals (FS94-10)
- Transitioning to Sustainable Methods in Sugarcane Farming (AS94-17)
- Intercropping Small Grains and Lupin for Sustainable On-Farm Utilization (LS94-62)

1993

- Warm-Season Forage Grasses as Rotations for Sustaining Profitable Peanut Production (LS93-51)
- Sustainable Whole Farm Grain/Silage Production Systems for the Southeast (LS93-53)
- Cover Crop Integration Into Conservation Production Systems For Cotton and Sorghum (LS93-55)

1992

- Farm Scale Evaluation of Alternative Cotton Production Systems (LS92-47)
- Use of Organic Nitrogen Sources for Sweetpotatoes: Production Potential and Economic Feasibility (LS92-45)

1991

- Utilization of Winter Legume Cover Crops for Pest and Fertility Management in Cotton (LS91-40)
- Improved Nitrogen Use-Efficiency in Cover Crop Based Production Systems (LS91-35)

1989

- Development of a Low-Input Multiple Cropping System for Small-Scale Farms (LS89-16)
- Enhancing Farmer Adoption and Refining of a Low-input Soybean-Wheat System (LS89-12)

1988

- A Comparison of Cropping Systems Managed Conventionally or with Reduced Chemical Input (LS88-09)
- Low-input Reduced Tillage Crop Production Systems for the Southern United States (LS88-07)

1995

- Demonstration of No-Till Cotton Production Using Best Management Practices (FS95-23)
- Demonstration of No-Tillage Grain Production for Soil and Moisture Conservation (FS95-22)

1992

- Use of Organic Nitrogen Sources for Sweet Potatoes: Production Potential and Economic Feasibility (AS92-06)

Western Region

1997

- Advancing Sustainable Potato Production in the Northwest (SW97-074)
- Decomposition and Nutrient Release Dynamics of Cover Crop Materials (SW97-045)
- Sustainable Culture of the Edible Red Seaweed *Gracilaria parivspora* Abbott in Traditional Hawaiian Fishponds (SW97-25)
- No-till Forage Establishment to Improve Soil and Water Conservation and Reduce Associated Production Risks (SW97-12)
- Sustainable Crop Production Practices with Mixed Leguminous and Non-leguminous Cover Crops (SW97-11)
- Alternative Cropping for the Navajo Reservation (FW97-065)
- Small Farm Harvest Labor Reduction Project (FW97-051)
- Non-irrigated Alfalfa Performance Trial, Benewah County, Idaho (FW97-049)
- Dryland Corn Production in Columbia and Walla Walla Counties (WA) (FW97-046)
- Value Added Wheat Production (FW97-042)
- Increased Forage Production during Alfalfa Crop Rotation Years in Johnson Canyon, Utah: Biological Control of Scotch and Bull Thistle on Disturbed Alfalfa Pastures (FW97-038)
- Bamboo Alternative Crop for Southwest Washington (FW97-010)
- Using Truffles to Enhance Douglas Fir Production on a Small Family Farm (FW97-007)

1996

- Identification of Management Practices and Cultivars for Organic Hard-Winter Wheat Production (SW96-32)
- Potential of a Corn/Annual Medic Intercropping System for Weed Control, Reduced Soil Erosion and Improved Forage Production (SW96-29)
- Establish More Efficient and Biological Practice for Bringing Forest Land into Agricultural Use through Sustainable Development Using Indigenous Species in Alaska (FW96-082)
- Achieving Sustainability in San Juan County Hay Fields (FW96-055)
- Test Plot Demonstration for Organically Produced Small Grains, Phase II (FW96-046)
- Alternative Crop Production in a "Direct Seed Annual Crop Intense Rotation Program" (FW96-041)
- Improved Nitrogen Utilization and Herbicide Reduction Through Relay Intercropping (FW96-014)

1995

- Establish More Efficient and Biological Practice for Bringing Forest Land into Agricultural Use through Sustainable Development Using Indigenous Species in Alaska (FW95-111)
- Relay/Cover Crop for Corn (FW95-100)
- Evaluation of Alternative Crops in Dryland Multi-Crop Rotations on Farms in the Northeastern Colorado Region (FW95-047)
- Test Plot Demonstration for Organically Produced Small Grains (FW95-003)

1994

- The Transition from Conventional to Low-Input or Organic Farming Systems: Soil Biology, Soil Chemistry, Soil Physics, Energy Utilization, Economics, and Risk (SW94-17)
- Fall-Planted Cover Crops in Western Washington: A Model for Sustainability Assessment (SW94-08)

1993

- Introduction of Cover Crops Into Annual Rotation in Northern California (AW93-14) Calibration of Pre-Sidedress Soil Nitrate Test to Improve Nitrogen Management on Dairy Farms (AW93-11)

1991

- Development of Winter Wheat Cover Crop Systems for Weed Control in Potatoes (LW91-27)
- Canola, Rapeseed, and Spring Pea as Enhancers of Soil Nutrient Available and Crop Productivity in Cereal Rotations (Cropping Rotations Directly Linked to Barley Yields) (AW91-03)

1989

- Low-Input Legume/Cereal Rotations for the Northern Great Plains/Intermountain Region (LW89-14)
- Cereal-Legume Cropping Systems: Nine Case Studies in the Dryland, Small Grains-Fallow Area of the Inland Northwest and High Plains (LW89-12)

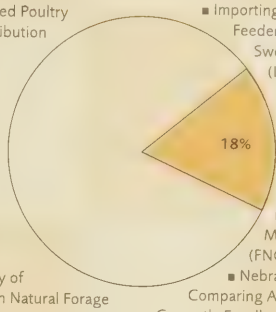
1988

- Planning Funds to Support Development of a Proposal on Low-Input Rice Production in Northern California (LW88-10)

ANIMAL PRODUCTION PROJECTS

North Central Region

1997



- Evaluating Pasture-Based Poultry Systems: Potential Contribution to Farm Diversification, Human Nutrition, and Marketing Alternatives (LNC97-121)
- Use of a Vegetative Filter as an Alternative Waste Management System for a Sustainable, Seasonal Management-Intensive Grazing Dairy (LNC97-120)
- Improving Sustainability of Cow-Calf Operations with Natural Forage Systems (LNC97-119)
- Maximizing Forage and Minimizing Grain Intake in Bison Fed for Meat (LNC97-113)
- Tree Filter & Wetland Livestock Waste Management Plan (FNC97-198)
- Rotational Grazing in South Dakota/Dairy Cattle (FNC97-185)
- Increased Pasture Profitability Through South African Dorper Sheep (FNC97-182)
- The Custom Grazing of Replacement Dairy Heifers on Fuego Fescue and Barenbrug Ryegrass Pasture Under a Management-Intensive Grazing System (FNC97-179)
- Grazing Yearlings on Annual Forage Pastures (FNC97-176)
- Conversion of a Marginal Row-Crop and CRP Farm to a Seasonal Grass-Based Dairy (FNC97-174)
- Swine Finishing in a Hoop Structure with Deep Bedding (FNC97-172)

1996

- Restoration of Economic and Ecological Sustainability in Western Rangeland: A Handbook (LNC96-108)
- Developing Sustainable Hog Markets and Slaughtering Arrangements for Family Farmers in Missouri (LNC96-105)
- The Adams County CRP Research and Demonstration Project (LNC96-097)
- Livestock Re-Establishment Research Project at White Violet Farm (FNC96-160)
- Exploring Low-Input Alternative for Watering Ewes in Winter (FNC96-159)
- Hog Production in an Existing Facility using Swedish Techniques (FNC96-158)
- An Analysis of Producing and Niche Direct Marketing Pasture-Finished Beef (FNC96-154)
- Life after CRP: The Conservation and Economic Benefits of Improved Grassland Cover Using Managed-Intensive Grazing (FNC96-150)
- Sheep Offal Composting Project (FNC96-147)
- Pipestone Lamb Marketing Project (FNC96-145)
- Finishing Beef Calves on Legume Pasture (FNC96-144)
- Networking and Education of Sustainable Bison Producers in the Northern Plains (FNC96-143)
- Erosion-Sensitive Farm is Converted to a Clean Water Farm that Includes a Management-Intensive Rotational Grazing System and Well-Planned Calving Facility (FNC96-142)
- Extending the Grazing Season in a Rotational Grazing System for Dairy (FNC96-140)
- Management-Intensive Grazing (FNC96-132)
- Comparison of Finishing Pig Performance in Hoophouse Building vs. a Conventional Slatted, Curtain-Sided Building (FNC96-131)
- Establishment of Rotational Grazing System Utilizing Warm and Cool Season Grasses (FNC96-161)

1995

- Impacts of Intensive Rotational Grazing on Stream Ecology and Water Quality (LNC95-89)
- Importing a Sustainable Model of Feeder Pig Production from Sweden: A Cooperative Project (LNC95-80)
- Incorporating Holistic Resource Management (FNC95-120)
- Lane Construction: Maintaining High-Quality/ Quantity Pastures, Protecting the Environment and Maximizing Profits (FNC95-097)
- Nebraska CRP Research Project Comparing Alternative Uses of Land Currently Enrolled in the CRP Program (FNC95-96)
- Intensive Grazing Economic Study (FNC95-95)
- Pastured Poultry (FNC95-94)
- Composting Poultry and Swine Carcasses (FNC95-93)
- On-Farm Systems Research to Raise Slaughter- Ready Beef on Pasture and Grain with Market Development (FNC95-92)
- Winter Farrowing in a Low-Input System (FNC95-89)
- Converting Continuous Grazing to Managed Grazing (FNC95-127)
- Tar Box Hollow Living Prairie (FNC95-126)
- Evaluation of Kura Clover in Intensive Grazing Systems (FNC95-124)
- Establishing Legumes in Cool Season Grass Pastures (FNC95-123)
- Stockpiling Pasture by Interseeding Annual Rye into Existing Pasture (FNC95-122)
- Orchard Mason Bees: Collection and Use in Southwest Wisconsin (FNC95-121)
- Free-Range Poultry Production and Management (FNC95-118)
- Measuring the Rate of Benefit Accrual Due to Adoption of a Management-Intensive Grazing System on a North Missouri Hill Farm (FNC95-115)
- Suitability of Non-Native Hardy Forage-Adapted Mutton Sheep to a North American Management- Intensive Grazing System (FNC95-100)

1994

- Pasture-Based Beef Finishing Systems (LNC94-76)
- Improving Sustainability of Cow/Calf Operations with Natural Forage Systems (LNC94-74)
- Comparing Finisher Pig Performance in a New Low-Cost Canvas Shelter as Compared to Conventional Confinement Barns (FNC94-062)
- Multi-Phase Swedish-Style Hog Structure with Attached Pastures (FNC94-88)
- Evaluation of an Alternative Farming Concept Strip Cropping and Pasture-Raised Hogs (FNC94-84)
- On-Farm Composting of Livestock Manure (FNC94-83A)
- Pasture-Raised Poultry and Hogs (FNC94-81)
- Low-Cost Waste Management in Beef Cattle Operation (FNC94-79)
- Incorporating Rotational Grazing into Conventional Dairy Enterprise (FNC94-78)
- Composting Swine Carcasses (FNC94-77)
- Low-Input Portable Sheep Dairying (FNC94-76)
- Alternative Use of CRP Acres: Grass Fat Lambs (FNC94-71)
- CRP Research Project - Comparing Alternative Uses of CRP Acres (FNC94-69)
- On-Farm Grazing Systems Research and Development of Intensive Grazing Software (FNC94-67)
- Pasture Renovation and Reseeding (FNC94-66)

- Improving Native Wet Meadows (FNC94-64A)
- Utilizing Chopped Wasted Paper for Bedding in Hog Operation (FNC94-62)
- Livestock Watering System (FNC94-61)
- Establishment of Cool Season Pasture in Nebraska Sandhills (FNC94-59)

1993

- Low-Input Beef Cattle Systems of Production (LNC93-54)
- Evaluating Various Forage Combinations in a Rotational Grazing System (FNC93-57)
- Evaluating Various Forage Combinations in a Rotational Grazing System (FNC93-55)
- Evaluating Different Forages in Rotational Grazing Systems (FNC93-54)
- Establishment of Warm Season Grasses and Interseeding Legumes into Cool Season Pastures (FNC93-53)
- Transition from Confinement to Grazing in Beef Cattle Production (FNC93-47)
- Evaluating Forages in Rotational Grazing System for Dairy (FNC93-43)
- Developing Dairy Heifers on Pasture (FNC93-40)
- Manure Composting in Dairy Operation (FNC93-37)
- Model Watering System for Rotational Grazing (FNC93-36)
- Intensive Rotational Grazing for Sheep (FNC93-35)
- Evaluating Productivity of Various Pasture Species by Utilizing Comsec Pasture, Gauge and Bulk Density Plates (FNC93-33)
- Evaluating and Comparing Beef Cattle Grazing Systems (FNC93-32)

1992

- Rotational Grazing Systems for Wisconsin and Minnesota Dairy Farmers: An Evaluation of Animal and Forage Performance and Whole-Farm Socio-Economic Analyses (LNC92-53)
- Training for Forage Production and Intensive Grazing on Highly Erodible Land After CRP Contracts (LNC92-51)
- Intensive Rotational Grazing System in the Flint Hills of Kansas (FNC92-23)
- Establishment of Native Warm and Cool Season Grasses on Highly Erodible Land (FNC92-22)
- Evaluation of Rotational Grazing in Established Mixed-Grass Pasture, and Interseeding Legumes into Winter Wheat (FNC92-20)
- Evaluating Rotational Grazing in the Development of Replacement Dairy Heifers (FNC92-19)
- Fall-Sown Rye for Fall and Spring Grazing and Green Manure (FNC92-17)
- Evaluation of Forages in Rotational Grazing System for Dairy (FNC92-10)
- Comparing Various Grasses and Legumes for Dairy Cattle in a Rotational Grazing System (FNC92-08)
- Evaluation of Various New Zealand Forages in Sheep Production (FNC92-06)

1991

- Planned Grazing Systems for Sustainable Livestock Production (LNC91-38)
- Demonstration of Livestock Grazing as an Alternative to Row Crops on Highly Erodible Land Following CRP Contracts (LNC91-36)

1990

- Ruminant Production Systems Inter-Related with Non-Traditional Crop Management (LNC90-30)
- The Krusenbaum Farm — A Case Study and Model in the Establishment of an Organic Dairy Farm (LNC90-28)
- Rotational Grazing Systems for Wisconsin and Minnesota Dairy Farmers — An Evaluation of Animal and Forage Performance and Whole-Farm Socio-Economic Analysis (LNC90-27)

1988

- Performance and Economics of a Low-Input Farrow to Feeder Swine Operation (LNC88-20)
- Low-Input Beef Cattle Systems of Production (LNC88-19)

Northeast Region

1997

- Eastern Gamagrass Determining its Feasibility as a Forage Crop for the Northeast (LNE97-96)
- Efficacy Evaluation of Homeopathic Nosodes for Mastitis and Calf Scours, and Documentation of Homeopathic Practices in Organic and Conventional Dairy Production (LNE97-86)
- Mixed Field Forage (FNE97-187)
- Development of NOFA Certified Pastured Poultry Contractual Company to Diversify and Revitalize Vermont Agricultural Industry (FNE97-181)
- Composting Tobacco Stalks Using PAW (Passive Aerated Windrow) System (FNE97-165)

1996

- Evaluating a Heat Therapeutic Control of the Honey Bee Mite Varroa Jacobsoni (LNE96-66)
- Establishing an Integrated Rotational Grazing & Watering System (FNE96-156)
- Full Capitalization of Water Resources (FNE96-150)
- Improving Aquaculture Productivity & Safety with Dockside Elevator Systems (FNE96-148)
- Crownvetch Living Mulch Grazing (FNE96-134)
- 4-H Sustainable Approach to Raising Beef (FNE96-125)
- Use of a Biological Filter in a Recirculating Aquaculture System (FNE96-121)
- Minimizing Equipment Costs on a Grazing Farm (FNE96-120)
- Maximizing the Benefit of Rotational Pasture by Using a Combination of Early Calving and Creep Feeding Heavy Calves Barley on Pasture (FNE96-119)

1995

- Managing Dairy Waste Using Constructed Wetlands & Composting (LNE95-62)
- Control of Gastrointestinal Nematodes in Dairy Cattle Under Intensive Rotational Grazing Management (LNE95-55)
- Expanding Profits for Sheep Production Through Intensive Pasture Management (LNE95-54)
- Fescue Endophyte Research Study (LNE95-52)
- Canaan Valley Agricultural Cooperative Waste Management Project (FNE95-88)
- Towards Aquaculture (FNE95-83)
- Quick Protein (FNE95-113)
- Once Daily Milking - Organic Dairy Herd (FNE95-112)

1994

- Expanding Profits for Vermont Sheep Production through Intensive Pasture Management (LNE94-47)
- Improving Pollination for the Northeast: On-Farm Testing, Demonstration and Management of the Alfalfa Leafcutting Bee (LNE94-46)
- Increasing the Sustainability of Dairy Farms by Improving Persistence of White Clover in Pastures (in co-op 94-15) (LNE94-45)
- Optimizing Use of Grass on Dairy Farms for Environmental/Economic Sustainability (in co-op 94-08) (LNE94-42)
- Nutrient Management on Maine Dairy Farms (ANE94-20)
- Solar Heated Aquaculture System (FNE94-62)
- Aeration to Improve Sod Development (FNE94-61)
- Raising Lambs on Fresh Goats Milk (FNE94-56)
- Evaluating Hoophouses for Rotationally Grazed Turkeys (FNE94-51)
- Garlic: The Natural Wormer (FNE94-46)
- Minor Breed Turkeys —Growth Rate and Eating Qualities (FNE94-38)

1993

- Mountain Sheep Project (FNE93-23)
- Evaluation of Puna Chicory Overseeding in Sheep Pasture in Central New York (FNE93-21)
- Evaluation of the Economic and Environmental Impact of Amino Acid Based Laying Rations (FNE93-09)
- The Use of Rotational Grazing in the Production of Lambs for the Hothouse Market (FNE93-02)

1992

- Integrated Kenaf, Broiler Manure and Beef Production Systems (ANE92-14)

1991

- An Integrated Response to Pollination-Related Problems Resulting from Parasitic Honey-Bee Mites, the Africanized Honey Bee, and Honey-Bee Pathogens (LNE91-27)

1989

- Improving Milk Quality and Animal Health By Efficient Pasture Management (LNE89-17)
- Ruminant Animal Production Using Tyfon Forage Brassica (LNE89-12)

1988

- Northeastern Dairy Farm Forage Demonstration Project (LNE88-06)
- Improving Farm Profitability by Efficiently Using the Pasture Resource (LNE88-02)

Southern Region

1997

- Integration of Freshwater Prawn Nursery and Growout Systems Into Diversified Systems (LS97-89)
- Evaluation of a Low-Cost Innovative Ensiling System for Small- to Medium-Sized Dairy Operations (FS97-64)
- Algae-Based Winter Feed for Small-Scale Goat Farm Operations (FS97-61)
- Managed Grazing System to Increase Sustainability (FS97-56)
- Overwintering Survival of Kentucky Honeybees (FS97-55)
- Forest Site Preparation with Swine (FS97-54)
- Cool Season and Warm Season Grasses to Stabilize Erodible Soils and Increase Profitability (FS97-53)
- Effect of Different Application Rates of Swine Lagoon Effluent on Corn and Wheat (FS97-51)

1996

- Integration of Pastured Poultry Production into the Farming Systems of Limited Resource Farmers (LS96-76)
- Grazing Alternatives to Tall Fescue for Stocker Cattle (FS96-45)
- Can Organically Managed Native Warm Season Grasses Provide a Sustainable and More Cost
Effective Hay Source for a Family Operated Goat Dairy than Input Intensive Annual Sorghum/Sudan Grass Crosses? (FS96-36)
- Aquaculture Conversion Model Emphasizing Poultry and Hog Facilities Re-Use and Recycled On-farm Resources (FS96-35)

1995

- The Development of Pasture-Based Swine Production Systems for Limited Resource Farms in the Mississippi Delta (LS95-67)
- Hydroponic Vegetable Production in Conjunction with a Trout Farming Operation (FS95-34)
- Management of Artificial and Restored Wetlands to Improve Water Quality (FS95-30)

1994

- Regional Center for Sustainable Dairy Farming (LS94-63)
- Shrimp Polyculture in Existing Farms (FS94-17)
- Swine Lagoon Management System (FS94-12)
- Meat Goats for Weed Control and Alternative Income in Cattle Operations (FS94-08)
- Nutrient Evaluation and On-Site Composting of Poultry Litter (FS94-04)
- Development of Guidelines for and Demonstration of Efficient Treatment of Swine Lagoon Wastewater by Constructed Wetlands (AS94-16)
- Integrated Grazing Systems Planning and Decision Support for Improved Sustainability and Environmental Quality (AS94-15)
- Forage, Biomass and Biogas Integrated Systems for Animal Waste Management (AS94-14)
- Waste Management Systems for Loafing Areas in Dairies (AS94-12)

1993

- Evaluation of Low-Input, No-Till, No-Herbicide Continuous Grazing System for Dairy Cows (LS93-54)
- Utilization of Dairy Manure in Low-input, Conservation Tillage Animal Feed Production Systems (LS93-52)

1990

- Swine Waste — Low-Cost Alternative to Commercial Fertilizer for Production of Forage for Grazing Cattle (LS90-26)
- Development of an Environmentally Safe and Economically Sustainable Year-Round Minimum
- Tillage Forage Production System Using Farm Animal Manure as the Only Fertilizer (LS90-24)

1989

- Development of a Plan for Implementing a Low-Input Sustainable Forage Production System in the Oklahoma-Arkansas Ozark Highland Region and Similar Land Areas (LS89-19)

Western Region

1997

- Management, Impact and Economics of Beef Cattle Grazing in Mountain Riparian Ecosystems (SW97-10)
- Pasture Fryer Chickens (FW97-045)
- Paradise Time Controlled Grazing (FW97-044)
- Perennial Grass Establishment in Existing Alfalfa (FW97-032)
- Vegetation Management on Small Acreages Using Short Duration, Intensive, Rotational Grazing (FW97-019)
- Individual Confinement Rearing vs. Pasture-Based Group Rearing of Dairy Calves (FW97-012)

1996

- Controlled Grazing on Foothill Rangelands (SW96-21)
- Reducing Environmental Contamination from Feedlot Manure in the South Platte River Basin through Agronomic, Economic, and Social Analysis and Education (SW96-07)
- Vegetative Changes through Alternative Water Sources (FW96-083)
- Pig Manure Control and Utilization Project (FW96-079)
- Evaluation of Grass Species for Improved Pasture Management (FW96-073)
- Dry-Extrusion of Wet Garbage for Swine Feeding (FW96-0029)
- Tall Stature Grasses for Winter Grazing and Spring Calving (FW96-023)
- Moving Succession Forward in a Lahmann Lovegrass Monoculture (FW96-010)
- Increasing the Value of Irrigated Pastures (FW96-001)

1995

- Extending the Grazing Season and Integrating Crops and Livestock to Sustain Small Farms and Ranches in the Southern Rockies (SW95-18)
- Sustainable Rangeland Based Beef Cattle Production Systems (SW95-07)

■ A Livestock Production System Less Reliant on the Use of Publicly Owned Lands (SW95-06)
■ Cattle Grazing Dispersion Methods and Riparian Ecosystems (AW95-102)
■ Influencing Elk and Livestock Riparian Use (FW95-093)
■ Pasture Aeration and Fertilizer Study (FW95-084)
■ Integrated Management to Improve Rangeland Health and Reduce Noxious Weeds (FW95-045)
■ Parasite and Nutrient Management of Composted Manure (FW95-027)
■ Carter-Fallon Forage Committee Range/Livestock Project (FW95-026)
■ Gila Permitees Association Elk Study (FW95-017)
■ Managing Riparian Areas with Remote Livestock Watering Facilities (FW95-008)

1994
■ Management of an On-Farm Composting System (AW94-10)
■ Compatibility of Livestock and Water Birds on Improved Pastures (AW94-03)

1993
■ Range Monitoring in the Upper Stony Creek Watershed (AW93-12)

1991
■ Integration of Aquaculture into an Irrigated Farm to Improve Efficiency of Water and Nutrient Use (AW91-02)

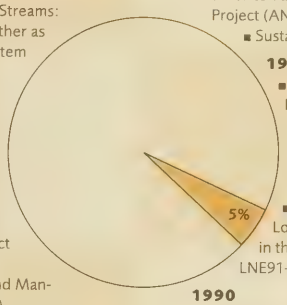
1988
■ Planning Funds to Develop a Proposal on Low-Input Animal/Range Systems (LW88-08)

NATURAL RESOURCE PROTECTION PROJECTS

North Central Region

1997
■ Cattle, Grass, and Streams: Can They Exist Together as a Sustainable Ecosystem (FNC97-177)

1996
■ Agricultural Wetland Management (LNC96-104)
■ Multiple-Use Borderlands: An Educational and Demonstration Project (LNC96-095)
■ Agricultural Wetland Management (ANC96-33)



1995
■ An Integrated Riparian Management System to Control Non-Point Source Pollution and Enhance Wildlife Habitat (ANC95-24)

1994
■ Revegetation and Succession of Western Kansas Riparian Site (FNC94-80)
■ Riparian/Range Restoration (FNC94-70)
■ Utilizing Native Sandhill Plum as an Income-Producing Windbreak (FNC94-68)

1993
■ Economic and Environmental Implications of 1990 Farm Bill Sustainability Provisions in Water Quality Sensitive Areas (LNC93-55)
■ Hazelnuts for Windbreak and Alternative Cash Crop (FNC93-42)
■ Hazelnut Windbreak Adds Diversity (FNC93-34)
■ An Integrated Riparian Management System to Control Agricultural Pollution and Enhance Wildlife Habitat (ANC93-17)
■ Wildlife Values of Sustainable Agricultural Practices in the Northern Great Plains (ANC93-15)

1992
■ Impact of Tree Windbreaks on Distribution of Insect Pests and their Natural Enemies in Sustainable Agricultural Systems (ANC92-12)
■ Impacts of Agricultural Management Systems on Economic, Environmental, and Wildlife Values of Altered and Unaltered Wetland Areas (ANC92-11)

1991
■ Reduced Chemical Input Production of Peaches (ANC91-09)
■ Influence of Cropping Systems on Contamination of a Shallow Aquifer in the Northern Great Plains (ANC91-04)
■ Wildlife Use of Experimental Intercropping Systems (ANC91-01)

Northeast Region

1997
■ Managed Riparian Buffer Zones and Cover Crops to Minimize Phosphorus and Nitrogen Runoff Losses from Corn Fields (LNE97-87)

1996
■ Northeast Kingdom Nutrient Management Project (LNE96-75)
■ Answering Questions About Ditch Bank Stabilization (FNE96-140)
■ Vegetative Filter Strips & Artificial Wetlands to Filter Silage & Manure Effluent (FNE96-122)

1993
■ Ecological Management of Potato Cropping Systems (LNE93-36/ANE93-18)
■ Improving Nutrient Management on a 100-Cow Free-Stall Dairy Farm (ANE93-17)
■ A Wetland Demonstration Project for Water Quality Improvement, Wildlife Habitat Creation, and Farmer Education (FNE93-27)
■ Integrated, Season Extension, Solar Greenhouse (FNE93-26)

1992
■ Farmer-to-Farmer Compost Exchange Project (ANE92-10)
■ Sustainable Landscapes (ANE92-09)

1991
■ Use of Composts and Reduced Applications of Fertilizer and Herbicides to Conserve Soil and Ground Water Resources in Nurseries (ANE91-07)
■ Implementing and Extending Low Input Cranberry Production in the Northeast (ANE91-02/ LNE91-26)

1990
■ Alternative Strategies for Cranberry Production in the Northeast (LNE90-26)

1989
■ Winter Cover Crops for Corn Production in the Northeast: N Balance and Soil Moisture Status (LNE89-13)

1988
■ Role of Cereal Grain Cover Crops in Nitrogen Management for the Chesapeake Bay Region (LNE88-03)

Southern Region

1997
■ Producers Assessment of Sustainable Land Management Practices to Protect Water Quality (LS97-88)

1996
■ Soil Conservation and Pest Management Impacts of Grass Hedges (LS96-73)

1995
■ Wildlife Enhancement and Education as a Catalyst in the Widespread Implementation of Sustainable Agriculture Practices (AS95-18/ LS95-65)

1993
■ Use of Poultry Litter as a Soil Amendment in Southern Row Crop Agriculture: A Feasibility Study Based on Agronomic, Environmental, and Economic Factors (LS91-39/AS93-10)
■ Evaluation of Recycled Paper Mulch as an Alternative to Black Plastic Mulch in Vegetable Horticulture (AS93-07)

1992
■ Developing Environmentally Sound Poultry Litter Management Practices for Sustainable Cropping Systems (LS92-48)
■ Effects of Sustainable and Conventional Agriculture on Farm Wildlife (AS92-05)
■ Habitat Enhancement for Beneficial Insects in Vegetable and Fruit Farming Systems (AS92-02)

1990
■ Development of Fractionation and Treatment Systems for Poultry Litter to Enhance Utilization and Reduce Environmental Impact (LS90-25)
■ Effective Nitrogen for Low-Input Forage and Grain Production in a Thermicudic Region (LS90-20)

Western Region

1997
■ Use of Sunnhemp in Cucumber Production (FW97-054)
■ Continuation of a Sustainable Agroforestry System (FW97-039)
■ Constructed Wetland for Waste Water Treatment (FW97-035)

1996
■ The Impact of Riparian Vegetation Filters on Western Soil and Water Quality: Nonpoint-Source Pollutants from Range and Croplands (AW96-14)
■ Goal-Driven Intensive Management of a Riparian/Sandy Bottom Site (FW96-012)

1995
■ Development of Sustainable Agroforestry System (FW95-105)
■ Flitner Wetland Habitat Enhancement Project (FW95-076)

1994
■ Rotational Management of Wetlands and Croplands in Tulelake Basin (AW94-020)

1993
■ A High-Input Crop Production System in Coastal California as a Model for Developing Indicators of Agroecosystems Sustainability (AW93-13)

1992
■ Development and Evaluation of Indicators for Agroecosystem Health (AW92-08)
■ Cover Crops Incorporated with Reduced Tillage on Semi-Permanent Beds: Impacts on Nitrate Leaching, Soil Fertility, Pests, and Farm Profitability (AW92-06)

1988
■ Compiling a Database of Sustainable Producers for the Southern Rockies Region (LW88-05)

ECONOMICS & MARKETING PROJECTS

North Central Region

1997
■ Development of Market Infrastructure to Support Local and Regional Food Systems (LNC97-122)
■ Processing and Marketing Milk Produced on Our Small Family Dairy (FNC97-199)
■ Community-Based Direct Marketing with the World Wide Web (FNC97-194)
■ Cooperative Marketing of Sheep Milk (FNC97-192)
■ Machinery Link Co. (FNC97-188)
■ Marketing On-Farm Composted Manure (FNC97-187)
■ Transition from Traditional Grain/Livestock Agriculture to On-Farm Roadside Marketing of Produce (FNC97-183)
■ Creating the Link: Cooperative Marketing of Organic (All-Natural) Beef (FNC97-171)
■ Feeding the Saints Pilot Project (FNC97-165)
■ Promotion of Crop Diversification and Research of Specialty Crop Markets for Western North Dakota (FNC97-164)
■ Building Community in CSA's: A Canning Project (FNC95-105)

1996
■ Farmer Marketing Information Co-ops (LNC96-110)
■ Prairie Hills Marketing Network: Marketing for Producers in Northwest Kansas (FNC96-157)
■ Prairie Farmers Co-op Producer-Owned Livestock Processing and Marketing (FNC96-156)
■ Northwood Farm Sustainable Raised Beef (FNC96-149)
■ Rural Action Ag Center (FNC96-146)

1995
■ Obstacles to Market Access for Family Farm Hog Producers (LNC95-92)
■ Development of a Rancher Cooperative to Market Grass-Fed Meat (LNC95-78)

1994
■ Investigation of the Viability of Growing Herbs as Alternative Crops for Iowa Farmers (LNC94-66)
■ Estimation of Reduced Machinery Ownership Costs in Diversified Cropping Systems (LNC94-63)
■ Cooler Development for Organic Meats and Produce (FNC94-85)

1992
■ Weed Control and Fertility Comparisons in Solid Seeded and 30 " Row Soybeans (FNC92-07)
■ Whole-Farm Economic Analysis of Medium-Sized, Single-Family Dairy Farms that Differ in Their Use of Purchased Chemical Inputs (ANC92-10)

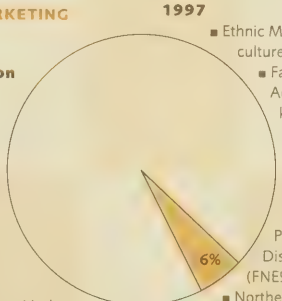
1991
■ Comparative Economic and Ecological Analyses of Lower Chemical Input Fruit Farms and Other Fruit Farming Systems (LNC91-37)

1989
■ Whole-Farm Economics and Nitrogen Budget Analysis on Low-Chemical and Conventional Wisconsin Farms (LNC89-012.1)

1988
■ A Statewide Collaborative Sustainable Agriculture and Outlook Project (LNC88-12)
■ An Economic Analysis of Producer and Industry Level Impacts of Low-Input Agriculture (LNC88-02)

Northeast Region

1997
■ Ethnic Markets and Sustainable Agriculture (LNE97-94)
■ Farmer-Centered, Value-Added Processing and Marketing Opportunities for Northeast Dairy Farmers: A Participatory Research and Development Project (LNE97-89)
■ Organic Meat/Poultry Processing, Marketing, and Distribution Effort (FNE97-183)
■ Northeast Livestock Export Program (Phase II) (FNE97-180)
■ Recycling Composted Poultry Manure to Grow Various Crops(FNE97-176)
■ Successful Marketing Through Product Identification/Packaging (FNE97-171)



1996
- Sorghum Syrup Production in Vermont (FNE97-188)
- Certified Organic Associated Growers (COAG) (FNE96-159)
- Northeast Livestock Export Program (FNE96-149)
- Dairy Farm Diversification/Waldo County, Maine (FNE96-137)

1995
- Community Supported Agriculture: Research and Education for Enhanced Viability and Potential in the Northeast (LNE95-63)
- An Economic Analysis of Community Supported Agriculture Consumers (LNE95-53)
- Profitability of Grass-Based Forages in SW New York (FNE95-78)

1994
- Establishment of a Production Line for Food Grade Rolled Organic Oats (FNE94-59)

1993
- Develop Crop Rotational Budgets for Three Cropping Systems in the Northeast (LNE93-35)
- Deep Root Organic Truck Farmers Co-op Mentor Program (FNE93-22)
- Stewardship Forestry on the Farm (FNE93-16)

1989
- Marketability of Low-input Agricultural Produce (LNE89-18)

Southern Region

1997
- An Integrated Vegetable Production, Postharvest and Marketing System for Limited Resource Farmers in South Georgia (LS97-87)
- Impacts on Agricultural System Sustainability from Structural Change in Peanut, Poultry, Swine, and Tobacco Production Systems (LS97-85)
- Sustainability Starts at Home—Building Regional Self Reliance through Agritourism (FS97-46)

1996
- Technical Assistance for Meat Goat Marketing (FS96-40)
- Group Strategic Alliances for Carroll County Feeder Calves (FS96-39)

1995
- Improving Quality of Slaughter Hogs as a Marketing Strategy for Small Producers (FS95-31)

1994
- Vegetable Marketing Strategies for a Small Farm Co-op (FS94-05)

1992
- An Integrated Technology and Marketing Strategy to Make Broiler Production More Sustainable (AS92-01)

1991
- Total Resource Budgeting of LISA Related Management Strategies (LS91-34)
- Reference Manual of LISA Resource Management Strategy Budgets for the Mid-South Region (LS91-33)
- Biological Control and its Economics in the Southern United States (LS91-31)

1989
- Composting Poultry Litter — Economics and Market Potential of a Renewable Resource (LS89-18)

Western Region

1997
- Converting Pasture Land to Specialty Crop Production as an Alternative Farm Enterprise (FW97-003)
- Vermicomposting Demonstration Project (FW97-016)

1995
- Sustainable Community Food Systems — A Catalyst for Rural Environment and Economic Regeneration - A Proposal for an Economic Feasibility Study (SW95-20)
- Developing an Idaho-Based Marketing Cooperative for Sustainability and Locally Grown Produce (FW95-046)

1994
- Western Region Community Supported Agriculture (CSA) Conference (SW94-22)

1991
- An Economic Evaluation of the MSU Crop Rotations On-Farm Research, Demonstration Legume, Cereal Rotations Compared with Conventional Rotations (LW91-02)

1989
- Total Resource Budgeting of LISA (SARE) Farm Enterprises (LW89-15)

COMMUNITY DEVELOPMENT PROJECTS

North Central Region

1997
- Linking Sustainable Agriculture Production with Low-Income and Minority Consumers (FNC97-197)

1996
- Increasing Rural Women's Leadership in Sustainable Agriculture and Community Development (LNC96-094)
- Iowa Network for Community Agriculture: Forming a Network to Support Producer Initiatives for Local Food Systems (CSA and Similar Efforts) in Iowa (FNC96-138)
- Community Farm Project (FNC96-129)

1995
- Regional Inventory and Assessment Project (QOL) (LNC95-93)
- Nebraska Ag IMPACT Project (LNC95-81)

1994
- Quality of Life Effects of Conventional, Transitional, and Sustainable Production Systems of Rural Communities and Family Farms in the Western Corn Belt (LNC94-65)

1993
- Sustainable Community Values Project (LNC93-61)
- Quality of Life Study: Comparing Conventional and Rotational Grazing Dairy Systems (FNC93-44)

1992
- Social and Cultural Factors Affecting Sustainable Farming Systems and the Barriers to Adoption (LNC92-50)
- Evaluating Relative Impacts of Conventional and Sustainable Farming Systems on Rural Communities (LNC92-48)
- Comparing Broadcasting and No-Till in Legume Establishment and Using Beef Tallow for Round Bale Weather Protection (FNC92-21)
- Quality of Life: Comparisons in Various Dairy Operations (FNC92-18)

1989
- LISA IMPACTS: Social, Economic, and Demographic Impacts of Low-Input Sustainable Agriculture Practices on Farms and Rural Communities in the Northwest Area (LNC89-23)

Northeast Region

1996
- Sea Change Urban Horticulture Center: Sustainable Agriculture Initiatives (LNE96-77)

1995
- Commercial Small-Scale Food Processing in New York: Value-Adding For Sustainable Agriculture (LNE95-60)

1994
- Project Farm Fresh Start: A Farm-to-School Feasibility Study (LNE94-49)

Southern Region

1997
- Regionally Centered Sustainable Agriculture System (LS97-84)
- The Hometown Creamery Revival (LS97-83)

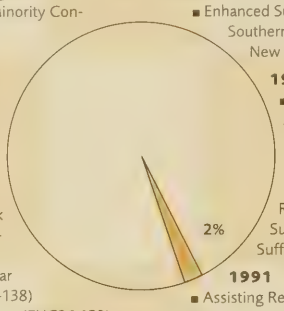
1996
- Implementation of Alternative Agriculture Strategies for Rural Community Sustainable Development Northampton County, Virginia (LS96-80)

1992
- Participatory Assessment for Strategic Planning in Sustainable Agriculture Research and Education (LS92-50)

Western Region

1997
- Building Community Support for Agriculture on the Urban Edge (SW97-43)

1996
- Enhanced Sustainable Agriculture in Southern Colorado and Northern New Mexico (SW96-27)



1994
- Sierra County Alternative Ag Project (SW94-37)

1992
- Wind River Visions: 2001 Northern Arapaho Tribal Rural Development through Sustainable Agricultural Self Sufficiency Project (LW92-32)

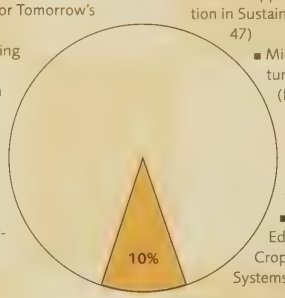
1991
- Assisting Resource-Poor, Small-Scale Farmers with Adoption of Low-Input Technologies through a Client Participation Program of Cooperative Research and Extension at the Rural Development Center Near Salinas, California (LW91-30)
- Farm Improvement Club Network for Sustainable Agriculture (LW91-23)

1988
- Native Crop Research Project (LW88-04)

EDUCATION PROJECTS

North Central Region

1997
- Yesterday's Research for Tomorrow's Needs (LNC97-123)
- Training and Transitioning New Farmers: A Practical Experiment in Farmer Self-Development and Institutional Reinvention (LNC97-115)
- Enhancing Adoption of Sustainable Agriculture Practices via Farmer-Driven Research (LNC97-112)
- Farm Beginnings: An Educational Training and Support Program to Establish Young Dairy Farmers in Southeast Minnesota (LNC97-111)
- Great Circle Farm CSA/Permaculture Demonstration Site (FNC97-191)
- Farmer Networking to Direct Precision Ag Technologies Toward Sustainability (FNC97-186)
- Innovative Farmers Seeking Sustainable Solutions Through On-Farm Demonstrations (FNC97-167)



1996
- Integration of Indigenous Knowledge of Sustainable Agricultural Systems (LNC96-107)
- Experiential Learning Activities for an Undergraduate Minor in Sustainable Agriculture Systems (LNC96-103)
- People to People: Sustainable Agriculture Networking for Farmers and Rural Communities (LNC96-098)
- Organic Farming Mentor Project (FNC96-130)
- Implementing Sustainable Agricultural Practices to Attain Organic Certification (FNC94-65)

1995
- Training and Transitioning New Farmers: A Practical Experiment in Farmer Self-Development and Institutional Reinvention (LNC95-88)
- Fresh-to-Processed: Adding Value for Specialty Markets (LNC95-87)
- FFA Participation in On-Farm Demonstrations of New Tools for Optimizing Use of Animal Manures in Crop Production (LNC95-84)
- Farmer-to-Farmer Cover Crop Network Complementing On-Farm and On-Station Trials (LNC95-83)
- The Development of an On-Farm Learning Center (FNC95-109)
- Getting Started in Farming Through Sustainable Agriculture (FNC95-103)
- Rotational Grazing Management Internships (FNC95-101)

1994
- Comparing Farming Systems with Different Strategies and Input Levels: A Research/Education Program with Replicated Micro-Farms (LNC94-73)
- Production of a Videotape Series Demonstrating Improved Grazing Practices to Promote Forage-Based Livestock Production in the Upper Midwest (LNC94-71)
- Future Farmers in Sustainable Agriculture (LNC94-67)

1993
- Sustainable Community Values Project, Phase 2: Community Supported Agriculture and Quality of Life (LNC93-61.1)
- Sustainable Agriculture Mentor Program (LNC93-60)
- Beginning Farmer Sustainable Agriculture Project (LNC93-59)

1992
- Further Development of Innovative and Practical Education in Sustainable Agriculture in Ohio (LNC92-47.1)
- Innovative Approaches to Practical Education in Sustainable Agriculture (LNC92-47)
- Midwest Alternative Agriculture Education Network (LNC92-45)
- Regional Extension and Education Curricular Materials for Sustainable Agriculture: A Planning Conference (LNC92-43)
- Regional Workshop for Educators on the Use of Cover Crops in Sustainable Farming Systems (LNC92-42)

1991
- Participatory Research and Education Network for Sustainable Agriculture in Illinois (LNC91-40)
- Sustainable Agriculture Training and Support for High School Agriculture Instructors (ANC91-08)
- Sustainable Agriculture: Teaching Youth and Teachers (ANC91-07)
- A National Conference on Participatory On-Farm Research and Education for Agricultural Sustainability (ANC91-05)
- Proven Sustainable Practices From Nebraska Farmers (ANC91-03)
- Farmer-to-Farmer Mentorship and Innovative On-Farm Research (ANC91-02)

1989
- The Middle Border On-Farm Research Consortium (LNC89.011.1)
- Beginning Farmer Sustainable Agriculture Project (LNC89-014.1

1988
- Making the Conversion from Conventional to Sustainable Agriculture: A Videotape Series for Farmers (LNC88-18)
- On-Farm Experimentation with Practical Low-Cost Alternative for Including Livestock in Sustainable Farming Systems (LNC88-14)
- The Middle Border On-Farm Research and Information Network (LNC88-11)
- Sustainable Agricultural Education Display Systems (LNC88-08)
- Low-Input (Sustainable Agriculture) Database and Information System (LNC88-07)
- Low-Input Agriculture and Cover Crop Workshop for Extension and Research Personnel from Nebraska, Iowa, Kansas, and Missouri (LNC88-05)
- Sustainable Low-Input Agriculture: An Overview Videotape (LNC88-04)

Northeast Region

1997
- CORE VALUES Northeast: A Northeast IPM— Apple Consumer Education and Market Development Project (LNE97-88)
- Design and Implementation of a Searchable Database on Compost Production and Use for Internet Users (LNE97-84)
- Education of the Public in the Use of Native Woodland Plants and Wildflowers in the Home Garden (FNE97-182)
- Technical Assistance for New Sheep Dairy Farms (FNE97-178)

1996
- Outreach and Training for On-Farm Composting (LNE96-76)
- Compost Laboratory Education Project (LNE96-71)
- Farming for the City Conference (LNE96-68)
- Farm to School Food Education Project (LNE96-65)
- Development & Adoption of Computerized Crop Record-Keeping Program (FNE96-145)
- Agri-Tourism: Educating the Public and Generating On-Farm Income (FNE96-132)

1995
- Resource Conservation & Environmental Stewardship in the "Maryland Ag in the Classroom" Curriculum Guide (LNE95-61)
- Mentoring Program (FNE95-100)

1994
- Water Conservation at the Woodvale Farm (LNE94-48)
- Farmer-to-Farmer Directory and Conference (LNE94-41)

1993
- Biodiversity Education through the Pennsylvania Forest Stewardship Program (LNE93-38)

1992
- Decision Making in Sustainable Agriculture Systems (LNE92-30)

1991
- The Northeastern Farmer-to-Farmer Information Exchange (LNE91-28)
- Information Dissemination to Increase the Utilization of Soil-Improving Cover Crops in the Northeast Cropping Systems (ANE91-06)

1989
- Northeastern Organic and Sustainable Farmer Network: Manual of Current Practices, Extension Training and Field Days (LNE89-14)

1988
- Taking Charge: Strategies for Sustainable Agriculture in the Northeast (Video Presentations) (LNE88-11)

Southern Region

1997
- Equal Access to Agriculture Programs and Opportunities: Advocacy to End USDA Racial Discrimination and Reestablish Viable and Sustainable Minority Farm Agriculture (LS97-86)
- Saving the Southern Legacy: Heirloom Plants and Local Knowledge for Profitable, Sustainable Agriculture (LS96-78)

1996
- Low-Input Sustainable Agriculture Short Course (FS96-42)

1995
- Using Farm Family Studies to Teach Sustainable Agriculture (LS95-68)
- Developing Municipal/On-Farm Linkages for on-Farm Composting and Utilization of Yard Wastes (LS95-71)

1994
- Integrating Sustainable Forestry into Whole Farm Management of Minority and Limited Resource Landowners in Three Regions of Arkansas (LS94-61)
- Post-CRP Land Management and Sustainable Production Alternatives for Highly Erodible Land in the Southern Great Plains (LS94-58)
- Farmer-to-Farmer Transfer of Knowledge About Rotational Grazing (FS94-15)

1992
- Southern Region Sustainable Agriculture Workshop (LSE92-01)

1991
- Smart—Sustaining and Managing Agricultural Resources for Tomorrow: Training for the Southern Region (LS91-44)
- Cover Crops for Clean Water: A National Conference on the Role of Cover Crops in Improving Water Quality (LS91-43)
- Intensive Short Course on Grant Preparation for Future Applicants to the LISA Competitive Grants Program (LS91-42)
- Economically Viable Production of Vegetables in the Southern Region Using Low-Input and Sustainable Techniques: A Data Base (LS91-32)

1990
- A Mid-South Conference on LISA-Related Agroforestry Practices and Policies (LS90-23)
- Influence of Integrated Pest Management (IPM) on Low-input Sustainable Agriculture (LISA) in the Southern Region (LS90-22)
- An Educational Program in Low-Input Sustainable Agriculture Production Technology and Philosophy (LS90-21)

1989
- On-Farm Demonstrations and Research of Low-Input Sustainable Farming (LS89-14)

1988
- Planning Funds for a Proposal on Extending the Issue of Sustainable Agriculture to Small Farms in North Carolina, Tennessee and Virginia (LS88-05)
- Planning Grant: Development of a Farmer/Extension/Research Network and Farming Systems Data Base for Low-Input Agriculture (LS88-04)
- Planning Grant: Development of Low-input Agricultural Technology Demonstrations at the Sunbelt Agricultural Exposition Demonstration Farm (LS88-03)

Western Region

1997
- Enhancing No-Till and Conservation Farming Success through the Use of Case Studies, Conferences, and Workshops to Facilitate Farmer-to-Farmer Learning in the Pacific Northwest (SW97-34)
- Blueprinting Traditional Sustainable Food Production Systems of Samoa in Development of a Research/Extension Model (SW97-13)

1996
- Sustaining Agriculture and Community: Moving the Farm Improvement Club Program beyond the Farm Gate (SW96-19)
- Western Integrated Ranch/Farm Education (SW96-10)
- School Cafeteria Compost System for Soil Amendment Production (FW96-059)
- Farming, Agriculture, and Resource Management for Sustainability (FARMS. (FW96-053)
- Managing Biological Processes for Maximum Diversity and Productivity (FW96-045)

1995
- Composting Farm and Kitchen Wastes in American Samoa (FW95-103)

1994
- Farming in the 21st Century: A Documentary Photography Project (SW94-54)
- Western Integrated Ranch/Farm Education (SW94-34)
- Sustainable Agriculture Training Project: A Model of Collaborative Learning (EW94-06)

1993
- Educational Video on Management of Pinon-Juniper Ecosystems — A New Approach (AW93-10)

1992
- Conference on the Science of Sustainable Agricultural Systems (LW92-05)
- The Sustainable Farming Quarterly (SFQ) A Regional Newsletter (LW92-04)

1991
- Regional Farm and Research Center Matching System-FARMS (LW91-03)
- California Sustainable Agriculture Working Group (LW91-01)
- Practical Education in Sustainable Production Systems (LW91-25)

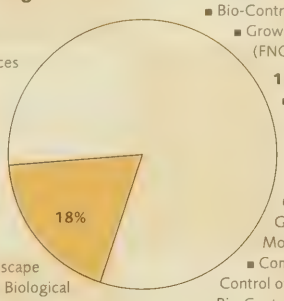
1989
- Information Delivery Systems for Use in Implementation of LISA (SARE) Research and Technology (LW89-21)
- Cover Crop Information for Researchers and Farmers (LW89-20)
- Livestock Health and Nutrition Alternatives: A Western States Conference (LW89-19)

1988
- Planning Funds to Foster the Development of a Consortium Network Information System Providing Gateway Linkage Between Users and Multiple Data Bases and Information Sources (LW88-09)
- Soil-Building Cropping Systems Conference-Legumes and Other Green Manures in Cropping Systems of the Northern Plains, Rockies and Intermountain Region (LW88-06)

PEST MANAGEMENT PROJECTS

North Central Region

1997
- Development of Sustainable Practices for Integrated Management of Apple Diseases (LNC97-124)
- A Sustainable Approach to Controlling Mite Pests of Honey Bees (LNC97-117)
- Combining Landscape and Augmentative Biological Control to Suppress European Corn Borer Populations in Sustainable Low-Input Systems (LNC97-114)
- Replacing Chemical Weed Control With Mulch in Commercial Blueberries (FNC97-193)
- Biological Control of Small Soapweed (Yucca glauca Nutt.) (FNC97-180)
- Integrated Row Tillage Project (FNC97-170)



- Development of Cultivation Equipment for Diversified Vegetable Production (FNC97-169)
- Composting For Disease Suppression (FNC97-163)

1996
- Evaluation of Composted Manure as a Growth and Delivery Substrate for the Biological Weed Control Agent, *Gliocladium virens* in Sustainable Vegetable Production Systems (LNC96-100)
- Biological Control of Foliar Diseases and Fruit Rots of Tomato (LNC96-099)
- Biologically Intensive Pest Management of Greenbugs, *Schizaphis graminum* (Rondani), on Grain Sorghum (LNC96-096)
- A Matted Mulch as an Alternative to Herbicide Use in Strawberries, Melons and Tomatoes (FNC96-151)
- The Study of Alternative Management Strategies for European Red Mite in North Central Ohio Apple Orchards (FNC96-141)
- Non-Chemical Suppression of Perennial Weeds (FNC96-137)

1995
- Weed Control for More Sustainable Soybean Production (LNC95-90)
- Ecological Principles of Habitat Management for Weed and Insect Biological Control (LNC95-85)
- Domestic Birds as Weed and Insect Pest Biocontrol Agents: Field Experimentation and On-Farm Evaluation (LNC95-82)
- Michigan 1995 Late Blight Education and Management Plan (ANC95-31)
- Reduced Tillage and Fungicide Input for Enhanced Sustainability in Fresh Market Tomato Production (ANC95-30)
- Utilization of Oilseed Rape as a Biocontrol Agent for Nematodes Parasitizing Corn in Illinois (ANC95-29)
- Reducing Herbicide Use with Machine Vision Technology (ANC95-28)
- On-Farm Evaluation of *Beauveria bassiana* for Long-Term Suppression of the European Corn Borer in Midwestern Cropping Systems (ANC95-27)
- Biological Control of Canada Thistles (FNC95-119)
- Sustainable Plum Curculio Control in Apple Orchards (FNC95-116)
- Protecting Beneficial Arthropods in Ohio Orchards (FNC95-104)
- Developing Weed Control Methods for Organic Raspberry Producers (FNC95-102)
- Weed Management Methods for Strip Intercropping (FNC94-82)

1994
- Development and Evaluation of Bio-Control Weed Management Systems for Low-Till Grain Production (ANC94-23)
- Continued Study of Controlling Leafy Spurge Utilizing Angora Goats (FNC94-74)
- Bio-Control of Leafy Spurge (FNC94-73)
- Growing Better Crops with IPM (FNC94-58)

1993
- A Biological Control Network for the Sweet Clover Weevil and Clover Root Curculio (LNC93-62)
- Assessing the Potential for Biological Control of Field Bindweed *Convolvulus arvensis* with the Gall Mite *Aceria malherbe*, and the Moth *Tyta luctuosa* (ANC93-18)
- Compost Extracts and the Biological Control of Foliar Plant Disease (ANC93-16)
- Bio-Control of Colorado Potato Beetle Utilizing Poultry (FNC93-56)
- Non-Chemical Weed Control in Row Crop Production (FNC93-48)
- Bio-Control of Plumeless Thistle (FNC93-30)
- Bio-Control of Leafy Spurge Using Angora Goats (FNC93-27)

1992
- The Adoption of LISA Techniques of Pest Management by North Central Fruit Growers (LNC92-52)
- Biological Control of Weeds in Corn and Soybean with Dwarf Brassica Smother Plants (ANC92-13)
- Using Poultry and New Scouting Techniques to Control Plum Curculio (FNC92-15)
- Biological Weed Control and Weed use Research (FNC92-12)
- Non-Chemical Fly Control in Beef and Dairy Herds (FNC92-11)

1991
- A Landscape Ecological Perspective in Insect and Weed Population Regulation in Low-Input and Conventional Systems (LNC91-39)
- Trap Cropping to Minimize Insecticide Application and Farm Input Costs in Sunflower Production (LNC91-32)
- Compost Extracts and the Biological Control of Foliar Plant Disease (LNC91-31)
- Whole-Farm Nutrient and Agchemical Input Budgeting for Sustainable Farming: Analysis and Demonstration (ANC91-06)

1989
- Development and Demonstration of Methods Toward Sustainable Apple Production (LNC89-22)

1988
- Utilization of the Allelopathic Properties of Winter Rye as a Method of Weed Control in Soybean Production (LNC88-21)

Northeast Region

1997
- Flowering Plants to Enhance Biological Control in Landscapes (LNE97-95)
- Integrating High-Density Orchards and Biointensive Integrated Pest Management Methods in Northeastern Apple Production (LNE97-90)
- Integration of Behavioral, Biological, and Reduced-Risk Chemical Approaches into a Sustainable Insect Management Program for Cranberries (LNE97-85)
- Biological and Cultural Methods of Insect Management in Vegetables: Survey and Case Studies of Organic Farms and Evaluation of the Scientific Literature (LNE97-82)
- Potential of Earthworms as Biocontrol Agents of Scab and Leafminers in New England Apple Orchards (LNE97-81)
- A Strawberry IPM Systems Comparison Demonstration (LNE97-80)
- Using Dogs to Control Bird Depredation of Blueberries (FNE97-184)
- Field Trials of Ag Covers to Reduce Cranberry Fruitworm Damage (FNE97-177) Biological Management of Colorado Potato Beetle (FNE97-172)
- No-Till vs Conventional Tillage for Butternut Squash Production and Phytophthora blight control (FNE97-169)
- Mechanical Cultivation and Fertility Workshops (FNE97-166)
- Christmas Lights and Deer Scents (FNE97-163)
- Biological Insect Control of Herbaceous Perennials (FNE97-162)

1996
- Peach Orchard Ground Cover Management to Reduce Arthropod Damage (LNE96-74)
- Sustaining Grape Production in the Northeast through Farm-Tested Information Technologies (LNE96-72)
- Enhancement of Sustainable Pest Management Techniques through Utilization of Banker Plants and Colored Mulches (LNE96-70)
- Demonstrations of Sustainable Vegetable Pest & Crop Management: Fresh Market Sweet Corn (LNE96-67)
- Impact of Herbicides on Beneficial Insects of Blueberry & Cranberry (LNE96-64/ ANE96-32)
- Biorational/Biological Management Program for Potato Pests (ANE96-31)
- Working Toward Implementation of a Disease Forecasting System for Fresh Market Tomatoes in Northern New Jersey (ANE96-30)
- Commercializing State-of-the-Art Thermal Aquatic Technology for Orchard Weed, Fungi, and Insect Control (FNE96-153)
- Broad Based Organic Control of Cranberry Fruit Worm (FNE96-143)
- Comparison of Drainage Methods for Phytophthora Root Rot Control (FNE96-142)
- The Efficacy of Red Oak Sawdust as a Mulch to Control Grass and Weeds in Organic Wild Blueberries (FNE96-136)
- High Density Planting for Weed, Disease and Pest Management in Commercial Strawberry Production (FNE96-131)
- Rotational Grazing of Sheep to Control Weeds in Christmas Trees (FNE96-126)

1995
- Implementation of a Disease Forecasting System for Tomatoes in Northern New Jersey (LNE95-59)
- Development of Fungal Entomopathogens for Greenhouse IPM (LNE95-58/ANE95-23)
- Integrating Microbial Insecticides and Oils into Sweet Corn IPM in MA (ANE95-26)
- Developing Sustainable Management Tactics for Cucumber Beetles in Cucurbits (ANE95-22)
- Predator Scent as a Deer Repellent in Christmas Tree Production (FNE95-93)
- Using Pastured Chickens for the Control of Colorado Potato Beetle (FNE95-92)
- Biocontrol of Two-Spotted Spidermite (FNE95-90)
- Organic Weed Management in Commercial Strawberry Production (FNE95-87)
- Sustainable Flea Beetle Management in Broccoli (FNE95-84)
- Encouraging Spiders for Pest Control: Comparing Mulches (FNE95-108)
- Determining the Efficacy of a Single Thinning Application of Carbaryl on Two Species of Foliar Feeding Leafhoppers on Apple to Reduce Late Season Pesticide Applications (FNE95-106)

1994
- Water Management to Minimize Pesticide Inputs in Cranberry Production (LNE94-50/ ANE94-21)
- Promoting Agricultural Sustainability through the Use of Rhizosphere-Competent Fungi as an Alternative to Soil Fungicide (LNE94-43)
- Integrating New Cultivation Technology and Photocontrol of Weeds to Reduce Herbicide Use in Vegetables (LNE94-40)
- The Evaluation and Demonstration of the Ability of Garden-Mate(tm) to Afford Adequate Herbicidal Activity in Sweet Corn at Reduced Rates of Atrazine and Metoloclor (FNE94-75)
- Organic Tomato Disease Control (FNE94-74)
- Encouraging Spider Population for Natural Pest Control (FNE94-71)
- Organic "Bag Culture" of Greenhouse Peppers (FNE94-70)
- Cover Crop Nematode Suppression (FNE94-68)
- Biological Control of Tarnish Plant Bug in Strawberries (FNE94-54)
- Demonstration of Reduced Fungicides for Control of Cranberry Fruit Rot (FNE94-49)
- Comparative Rotational/Cover Cropping for Weed Suppression (FNE94-47)
- Nematodes for Control of Plum Curculio (FNE94-40)
- Comparison of Organic Mulches for Perennial Quackgrass Control in Orchard Floor Management (FNE94-37)

1993
- Reactions of Peracetic Acid to *Botrytis cinerea* (FNE93-36)
- Evaluation of Integrated and Biological Pest & Disease Controls in Orchards (FNE93-33)
- New Sprayer Technology for Reduction of Pesticide Use in Apples (FNE93-31)
- Fiber-Producing Goats as an Alternative to Chemical Weed and Brush Control in Pasture Reclamation and Management (FNE93-25)
- Demonstrating a Sustainable Agricultural System by Using Beneficial Insects (FNE93-20)
- Evaluation of a Biocontrol Method for Farm Fly Management (FNE93-15)
- Bio-Control of Corn Earworm and European Corn Borer in Sweet Corn (FNE93-12)
- Flame Weed Control in Cut Flower Production (FNE93-08)
- Evaluation of Five Organic Techniques for Controlling Flea Beetles on Kennebec Potatoes (FNE93-04)
- Integrated Crop Management for Greenhouse Bedding Plants with Emphasis on Biological Control (FNE93-03)

1992
- Fungal Pathogens for Biocontrol of Western Flower Thrips and Green Peach Aphids in Greenhouses (LNE92-33)
- Fungal Pathogens for Biocontrol of Sweet-Potato Whitefly in Greenhouses (ANE92-15)
- Development, Demonstration, and Implementation of a Low Input, Sustainable Potato Integrated Crop Management Program (ANE92-13)

1991
- Alternate Management of Leafhopper Pests in Integrated Farming Systems: Demonstration of Biological and Cultural Controls (ANE91-05)

1990
- Novel Rotation Crops as Alternatives to Fumigant Nematicide Treatment in Deciduous Tree Fruit Production (LNE90-22)
- Honeybee Breeding for Tracheal Mite Resistance in the Northeastern United States (LNE90-21)

1989
- Evaluation of Alternative Strategies for Small Fruit Production (LNE89-16)
- Eggplant: A Model System for Integrating Biological Control of Colorado Potato Beetle and Verticillim Wilt (LNE89-15)

1988
- Development, Evaluation and Implementation of Low-Input Systems for Eastern Vineyards (LNE88-10)
- Weed Control in Reduced Tillage Cropping Systems: Use of Overseeded Cover Crops (LNE88-07)
- Development of a Low-Input Apple Production System for the Northeast (LNE8801/ ANE92-16)
- Northeast Region Sustainable Apple Project (LNE88-01B)

Southern Region

1997
- Controlling Cheat and Annual Ryegrass in Small Grains Using Novel Crop Harvesting Technologies (LS96-81/AS96-25)
- Crop Production Systems for Nonchemical Control of Reniform Nematodes (FS97-49)

1995
- Identifying Pesticides Most Compatible with Parasites of the Citrus Leafminer (AS95-24)
- Increasing Acceptance of Low-Input Landscapes for the Southeast (AS95-23)
- Biological Control of Silverleaf Whitefly in Floriculture (AS95-22)
- Reduced-Risk Cockroach Control in Confined Animal Production (AS95-21)
- Utilization of Natural Enemies, Viral Insecticides and Improved Information Delivery for Management of Lepidopterous Pests in Transgenic B.t. Cotton (AS95-20)
- Development of Biological Control Methods for Citrus Rust Mites and Spider Mites on Florida Citrus Utilizing Predaceous Arthropods as part of a Citrus Integrated Pest Management Program (LS95-66/AS95-19)
- Testing the Efficacy of Alternative Methods of Whitefly Control in Organic Vegetable Production (FS95-26)
- Alternative Control of Soil Diseases in Vegetable Production (FS95-24)
- Pecan IPM Using Black-Eyed Peas as a Trap Crop (FS95-21)

1994
- Development of Sustainable Area-Wide Weed Management Practices for Improved Land Utilization (LS94-64/AS93-08)
- Integration of Animal Waste, Winter Cover Crops, and Biological Antagonists for Sustained Management of Columbia Lance and Other Associated Nematodes on Cotton (LS94-60)
- Assessing the Impact of Beneficial Insect Populations on Organic Farms (LS94-59/AS94-13)
- Disease and Insect Management Using New Crop Rotations for Sustainable Production of Row Crops (LS94-57)
- Biological Control of Flower Thrips in Pepper Fields (FS94-19)
- Insect Pest Management for Cotton (FS94-06)
- Controlling Aphids with Harmonia Lady Beetle in Pecan Orchards (FS94-01)

1993
- Using Soldier Flies as a Manure Management Tool for Volume Reduction, House Fly Control and Feedstuff Production (LS93-56/AS93-09)
- Use of Poultry Litter or Manure for Root-knot Nematode Management on Vegetables and Field Crops (AS93-11)

1992
- Development of Cropping Systems for Nematode Management on Agronomic and Horticultural Crops (LS92-46)
- Integration of Natural Enemies for Management of the Sweet Potato Whitefly and Associated Disorders on Mixed Cropped Vegetables (AS92-03)

1991
- Uniform Spray Deposits for Reduced Pesticide Use in Weed and Insect Control Operations (LS91-41)
- Developing and Extending Minimum Input Strategies for Weed Control in Agronomic and Horticultural Crops (LS91-38)
- Pest Management and Orchard Floor Management Strategies to Reduce Pesticide and Nitrogen Inputs (LS91-36)

1990
- Substitution of Cultural Practices for Herbicides to Control Annual Rye Grass and Cheat in Small Grains (LS90-28)
- A Low-Input Manure Management System in Animal Housing for Housefly Control, Waste Reduction and Feed (LS90-27)

1989
- Substitution of Cultural Practices for Herbicides to Control Annual Rye Grass and Cheat in Small Grains (LS89-13)

1988
- Developing and Extending Minimum Input Strategies for Weed Control in Agronomic and Horticultural Crops (LS88-11)
- Solarization and Living Mulch to Optimize Low-Input Production Systems for Small Fruits (88-87-4) (LS88-10)
- Low-Input and Organic Pest Management for Apples and Peaches Using Mating Disruption and Ground Cover Management (LS88-01)

Western Region

1997

- Comparison of Pest Management Interactions in Spring Wheat-Cover Crop and Spring Wheat-Fallow Cropping Systems (SW97-56)
- Development and Implementation of Trap Cropping Strategies for Control of Hemipteran Pests in Pistachio Orchards (SW97-49)
- Reducing Insecticide Use on Celery Through Low Input Pest Management Strategies (SW97-21)
- Integrating Nematode-Resistant Crops into Sugarbeet Rotations (SW97-18)
- Management of Soil-borne Plant Parasitic Nematodes for Sustainable Production of Field Grown Tomatoes and Cucumbers by Cover Cropping (SW97-01)
- Limiting Gopher Deprivation by Time-Control Livestock Grazing (FW97-057)
- Biological Control of Pear Pests (FW97-041)
- Release of the Predator Mite, *Amblyseius fallacis* to Control Spider Mites in Red Raspberries and Reduce Reliance on Pesticides (FW97-033)
- Pheromone Foggers for Pesticide Replacement (FW97-030)
- The Use of Goats to Control Juniper, Sage & Rabbit Brush (FW97-020)
- Growing Ring-Spot Virus-Free Papayas Using Anti-Transpirants and Other Sustainable Techniques (FW97-017)
- Feasibility of Soil Solarization for Strawberry Production on the Central Coast of California (FW97-011)
- Sustainable Alternatives to Herbicide for Weed Control: Using Cover Crops to Combat *Panicum repens* and *Panicum maximum* in Lowland, Eastern Hawaii (FW97-004)
- "Foxtail" Reduction in Permanent Pastures (FW97-002)

1996

- Implementation and Assessment of Economic and Environmental Impact of a Weather Monitoring/Pest and Disease Risk Assessment Network in Commercial Pear Production in Oregon (SW96-13)
- Influence of Cover Crops and Tillage on Symphylans Density in Vegetables (AW96-19)
- Control of Leafy Spurge by Grazing Goats: A Demonstration (AW96-13)
- Reduced Herbicide Use through Improved Mechanical Cultivation and Banding of Herbicides (AW96-09)
- Weed Suppression and Enhancement of Wildlife and Beneficial Insect Habitat in Center Pivot Irrigated Field Borders and Corners (AW96-04)
- Organic Mulch for Weed Control in Rhubarb (FW96-068)
- Economic Viability of Greenhouse Solarization (FW96-060)
- Sustainable Greenhouse Tomato Production: Evaluating Alternatives to Pesticide Use for Controlling Tomato Pinworm Larvae in Hawaii (FW96-049)
- Carrot Rust Fly Control (FW96-042)
- Grazing Sheep in New Forest Plantings (FW96-037)
- The Effect of Aerated Compost Teas on Disease Control in Blueberries and Tomatoes (FW96-026)
- Use of Aerated Compost Teas as a Preventative Foliar Fungicide on Grape Vines Vitus vinifera (FW96-0019)
- Weed Control in Organic Apple Orchard (FW96-016)
- Use of Aerated Compost Teas for Control of Foliar Diseases of Spinach, Lettuce and Broccoli and to Promote Plant Vigor and Quality (FW96-013)
- Habitat Management as a Transitional Tool to an Insecticide: Free Pest Management Program in Apples (FW96-005)
- Low Tillage Weed Control (FW96-003)

1995

- Brassica Green Manure Systems for Weed, Nematode, and Disease Control in Potatoes (SW95-21)
- Development of a Farm-Wide System for Control of Many of the Principal Lepidopterous Pests of Grapes and Tree Fruits Based on Disruption of Premating Pheromone Communication Between Male and Female Moths (SW95-19)
- Application of *Pseudomonas corrugata* as a Seed Treatment to Suppress Ring Rot Disease of Potatoes (AW95-207)
- Effectiveness of *Beauveria bassiana* as a Microbial Control Agent for Coleopteran and Homopteran Pest of Irrigated Alfalfa (AW95-205)
- Non-Chemical Control of Bollworm and Pink Bollworm in Cotton and Automated Insect, Plant and Profit Analysis (AW95-203)
- Development and Demonstration of a Farm-wide System for Control of the Principal Lepidopterous Pests of Tomatoes Based on Disruption of Premating Pheromone Communication between Female and Male Moths (AW95-202)
- Controlling the Banana Scab Moth Caterpillar in American Samoa through Cultural Methods (FW95-106)
- Squash Bug Management through Introduction of Game Birds (FW95-080)
- Low Tillage Weed Control System (FW95-050)
- Row Spacing Effect on Weed Suppression (FW95-034)
- Biological Control in Idaho Alfalfa Seed Fields (FW95-025)

1994

- Apple Production Without the Input of Neuroactive Insecticides (SW94-23)
- Influence of Cover Crop and Non-Crop Vegetation on Symphylan (*Scutigerella immaculata*) Density in Vegetable Production Systems in the Pacific Northwest (AW94-33)

1991

- A Multidisciplinary Approach to Evaluate and Aid the Transition From Conventional to Low-Input Pest Management Systems in Stone Fruits (LW91-28)
- Brassica Utilization in Sugar Beet Rotations for Biological Control of Cyst Nematode (LW91-22)
- Soil Bacteria to Control Jointed Goatgrass in Integrated Cropping Systems (AW91-05)
- Use of Domestic Geese to Control Weeds for Agriculture and Forestry Applications in Alaska (AW91-01)

1989

- Bio-Priming for the Control of Pythium Reemergence Damping-Off in Vegetable Crops (LW89-16)
- Application of Low-Volume Water Systems to the Cultural and Biological Control of Root Diseases (LW89-13)

HORTICULTURE PROJECTS

North Central Region

1997

- Use of Cover Crop Practices to Control Weeds in Integrated Lower-Chemical Input Systems of Vegetable Production (LNC97-118)
- Ornamental Bittersweet Production for Small Woodland Farms (FNC97-195)
- Native Minnesota Medicinal Production Feasibility Study (FNC97-178)

1996

- Sustainable Mushroom Cultivation in the North for Disabled Growers (FNC96-162)
- Extending the Vegetable Production Season in Northern Michigan with Polyhouses (FNC96-152)
- Growing Day-Neutral Strawberries using the Sunbelt/Polyacrylamide Gel System (FNC96-135)

1995

- Harvesting Wildflower Seed Crops from Marginal Lands (FNC95-98)
- Native Elderberry and Plum as Income Source from Waste Ground (FNC95-106)

1994

- Sustainable Organic Apple Production (FNC94-75)
- Wildflowers on Marginal Lands (FNC94-72)

1993

- Evaluating Liquid Manure as Nutrient Source in a Commercial Orchard (FNC93-49)

1992

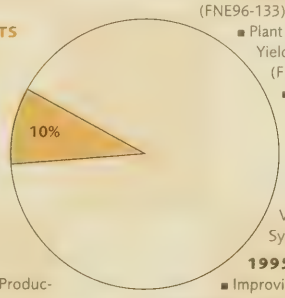
- Hairy Vetch as Weed Control Cover Crop in Vegetable Production (FNC92-14)

1991

- LISA as Applied to Vegetable Production Systems (LNC91-33)

1990

- Sustainable Production Systems for Vegetables (LNC90-29)



Northeast Region

1997

- Chinese Medicinal Herbs as Crops for the Northeast (LNE97-92)
- Nitrogen Management for Pumpkins and Squash (LNE97-83)
- Improving Production Methods for Shiitake Mushrooms (FNE97-189)
- Conservation of Wild Blueberry and Cranberry Pollinators (FNE97-175)
- Regulation of Lateral Branching in Genovese Basil (*Ocimum basilicum*) via Application of Bacterial Spray (FNE97-174)
- Greenhouse Subsurface Pipe System to Convert Solar Energy to Soil Heat (FNE97-173)
- Establishing and Enlarging on Maine Ginseng Production (FNE97-167)
- High Tunnel Strawberries for New England (FNE97-164)
- Echinacea Field Trials (FNE97-160)

1996

- At-Harvest Stalk Nitrate Testing for Sweet Corn (LNE96-73)
- Sorghum Syrup Production in Vermont (FNE96-157)
- Best Method for Establishing Globe Artichoke Seedlings (FNE96-151)
- Alternative Rotation System for Vegetables (FNE96-146)
- The Use of Ethylene as a Chemical Pinching Agent on Floricultural Crops (FNE96-141)
- Kenaf/Vegetable Rotation in an Organic Farming System (FNE96-139)
- Sustainable Pollination of Wild Blueberry and Cranberry (FNE96-138)
- The Development of Rhubarb Agriculture in Maine (FNE96-135)
- Sustainable Yield Sugaring & Marketing (FNE96-133)
- Plant Population Effect on Yields of Sweet Corn (FNE96-130)
- Pedal-Powered Tillage for a Small Community-Supported Farm (CSA) (FNE96-129)
- Permanent Bed Vegetable Production Systems (FNE96-117)

1995

- Improving the Profitability & Adaptation of the High-Density Strawberry Production System for the Northeast (LNE95-57)
- Presidedress Soil Nitrate Test for Fall Cabbage (LNE95-56)
- Best Methods of Establishing Newly Planted Cranberry Vine (FNE95-99)
- Viability of a Mechanically Killed Cover Crop in NE Vegetable Cropping (FNE95-98)
- Organic Tomato Production/Marketing Manual (FNE95-96)
- The Use of Ethylene as a Chemical Pinching on Agent Floricultural Crops (FNE95-94)
- Dehydrated Carrots: An Opportunity for Alternative Crops and Sustainable Agriculture in Northern Maine (FNE95-89)
- The Value of Low Maintenance Turfgrass for Cut Flower Production (FNE95-86)
- Season Extension For Vegetable Crops in Zone 4 (FNE95-85)
- Harvesting and Marketing Chinese Chestnuts (FNE95-80)
- Developing a Sustainable Approach to Hop Production in Northeast (FNE95-79)
- Utilizing a Living Mulch System for Specialty Cut Flower Production & Pasture Regeneration (FNE95-110)
- Season Extension Through Annual Organic Strawberry Production & Fall Vegetable Production (FNE95-104)
- Development of Woodlands Growing Method for New England Native Wildflowers & Medicinal Plants (FNE95-102)
- Organic Hardy Kiwi Production (FNE95-101)

1994

- Presidedress Soil Nitrate Testing for Sweet Corn (ANE94-19)
- Disease Forecasting/Reducing Fungicide on Grapes (FNE94-63)
- Early Winter Strawberry Production (FNE94-76)
- Increasing Options for Cover Cropping in the Northeast (FNE94-66)
- Long Term No-Till Cover Crop Seeding in Vineyards (FNE94-64)
- Evaluation of Water Retaining Soil Amendment, Cropping Systems and an Alternative Labor Source for Vegetable Production (FNE94-57)
- Lingonberry as an Alternative Small Fruit Crop (FNE94-55)
- Feasibility and Propagation of Leafcutter Bee in Maine (FNE94-53)
- Determination of Factors that Contribute to Alasa Farm's Significantly Lower Pesticide Costs when Compared to the Area Average as Reported in Cornell's 1992 Fruit Business Summary (FNE94-45)
- Finger Lakes Chestnut Project (FNE94-42)
- Trough Sub-Irrigation Versus Traditional Overhead Watering (FNE94-41)

1993

- Evaluation of Alternatives to Synthetic Chemicals and Lime for Nutrient Supply, Weed Suppression, and pH Control on Raspberry Plants (FNE93-35)
- Managing Crowded Woodlots though Shiitake Mushroom Production (FNE93-32)
- Soil Heating in Unheated Tunnels (FNE93-29)
- Cranberry 2000 (FNE93-24)
- Ginseng Production Project (FNE93-07)

1992

- Demonstrating the Economic and Environmental Advantages of Legume Cover Crops to New England Vegetable Growers (LNE92-31)
- Ecosystem-Based Orchard Management For Processing Apples (ANE92-12)
- Alternative Rotation System for Vegetable Production and Soil Conservation (ANE92-11)

1991

- Extension of the Pre-Sidedress Soil Nitrate Test for New Jersey Field and Sweet Corn Growers (ANE91-04)

1990

- Whole-Farm Impact of Converting Conventionally Managed Eastern Vineyards to Organic Management Practices (LNE90-20)

1989

- Reduced Tillage: Alternative Cropping Systems for Vegetable Production in the Northeast (LNE89-19)

1988

- Implementation of Electronic Decision Support Technology for Apple Production (LNE88-08)
- Cover Crops for New England Vegetable Growers: On-Farm Research, Economic Analysis and Outreach (LNE88-05)

Southern Region

1997

- Economics of Seasonal Extension of Cut Flower Production (FS97-60)
- Evaluation of an Alternative Low-Input Production System for Fresh Market Tomato (FS97-58)
- Effect of Limited Environmental Controls on Shiitake Mushroom Production in the Southern Coastal Plain (FS97-57)
- Sustainable Pumpkin Production in the Southeast (FS97-52)
- Evaluation of Mycorrhizal Inoculation on Growth and Quality of Three Eastern North Carolina Christmas Tree Species (FS97-48)

1996

- Development of Sustainable Cropping Systems for Seedless Watermelon and Fall Lettuce in Rotation with Green Manures (LS96-77)
- Developing Sustainable Crop Management Systems for Improving Production of Culinary Herbs in the Virgin Islands (LS96-75)
- Identification of Cover Crops to Enhance the Habitat of Specific Beneficial Insects in Sustainable Production Systems (FS96-37)
- Sustainable Cultivation of Medicinal Herbs as an Alternative to Tobacco as a Cash Crop (FS96-43)

1995

- Agronomic & Economic Benefits of Intercropping Bean with Banana (LS95-72)
- Managing Soil Phosphorous Accumulation From Poultry Litter Application Through Vegetable/Legume Rotations (LS95-69)
- Demonstration of the Use of Cover Crops in Integrated Vegetable Production Systems (FS95-33)
- Native Pecan Orchard Management Using Best Management Practices (FS95-32)
- Improving Tropical Soils by Utilizing Organic Wastes (FS95-28)
- Demonstration of High Value, Small Scale Sustainable Vegetable and Fruit Production Methods (FS95-27)
- Development of Potting Soil Mixes from Local Wastes (FS95-25)
- No-Till Vegetable Demonstration (FS95-20)

1994

- Cut Flowers as a Sustainable Agriculture Alternative (FS94-14)
- Plant Shelters to Extend the Growing Season for Herbs (FS94-13)
- Clover Clippings as Replacement for Chicken Litter in Compost (FS94-11)

Western Region

1997

- Growing American and Korean Ginseng in Alaska (FW97-026)

1996

- Evaluation of a Perennial Vegetable, Asparagus, as a New Commercial Crop for Hawaiian Farmers (SW96-03)
- Organic vs. Synthetic Fertilizer- Container Nursery Trials (FW96-067)
- Vegetable Soybean Cultivar Trials (FW96-030)
- Green Manure/ Covercrop Combination Experiment (FW96-007)

1995

- A Cover Crop System for Sustainable Grape Production in California — Beyond the Transition Phase (SW95-12)
- Orchard Alley Cropping the Subhumid Tropics (AW95-103)
- Managing a Living Mulch System in an Intensive Organic Vegetable Cropping Operation to Enhance Weed, Nutrient, and Pest Management (FW95-078)

1994

- Development and Demonstration of Integrated Vegetable Production Systems for the Maritime Pacific Northwest (SW94-29)

1992

- On-Farm Demonstration of Integrated Vegetable Production Systems for the Maritime Pacific Northwest (LW92-1)

1991

- Prune Refuges and Cover Crops to Facilitate Low-Input Production of California's Raisin, Table, and Wine Grapes (LW91-26)

1989

- A Comparative Study of Low Input and High Input Taro Production in American Pacific with Special Reference to Pest Control (LW89-11)

1988

- Planning Funds to Develop a Proposal to Study Low-Input and High-Input Taro Production (LW88-07)
- Evaluation and Design of Low-Input Sustainable Vegetable/Small Grain and Small Fruit Systems of Western Oregon and Washington (LW88-01)

PROFESSIONAL DEVELOPMENT PROJECTS

North Central Region

1997

- Professional Training in Soil Quality (ENC97-027)
- Multi-Agency On-Farm Sustainable Agriculture Training (ENC97-026)
- Grazing Education for Educators and Bankers (ENC97-025)
- Environment for Community Supported Agriculture (ENC97-024)
- Organic Vegetable Production Workshop (ENC97-023)
- Education for Permaculture as a Native Science (ENC97-022)
- Holistic Resource Management Workshop (ENC97-021)
- Legal Guide for Farm Marketers (ENC97-020)
- Minnesota Sustainable Farming Association Chapter Networking (ENC97-019)
- Opportunities for Families on Small Farms (ENC97-016.1)
- Self-Directed Participatory Agent Learning (ENC97-012.1)
- Sustainable Agriculture Distance Learning Curriculum (ENC97-002.2)

1996

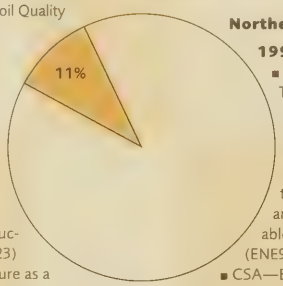
- Sustainable Agriculture Training Project for North Dakota and South Dakota (ENC96-02)
- Organic Production and Marketing Curriculum for Extension Professional Development (Merits and Adoptability of Organic Agriculture) (ENC96-18)
- In-Service Training in Sustainable Agriculture and Agricultural Ecology of NRCS Personnel and Partners (ENC96-17)
- Sustaining a Desirable Quality of Life through New Agricultural Opportunities for Farm Families on Small Farms (ENC96-16)
- Strengthening the Whole-Farm Planning Process through Producer-Agent Partnerships and Professional Development (ENC96-15)
- Decision Cases for Sustainable Agriculture: A Video Training Project for Professional Development (ENC96-14)
- Utilizing the Concept of Whole-Farm Planning to Educate Agricultural Professionals and Farm Families in Ohio about Sustainable Agriculture (ENC96-13)
- Participatory Learning between Farms and Field Crop Area of Expertise Team Members (ENC96-12)
- Accessing Community-Based Information Sources for Improving Surface Water Quality (ENC96-11)

1995

- Quality of Life Module for Extension Professional Development (ENC95-008)
- Building Collaborative Partnerships with Farming Systems Research and Extension (ENC95-10)
- A Comprehensive Educational Program for "Training the Trainers" in Sustainable Agriculture in Minnesota, Wisconsin, and Iowa (ENC95-09)
- Quality of Life Module for Extension Professional Development (ENC95-08)
- Experiential Co-Learning for Professional Development in Sustainable Agriculture (ENC95-07)
- Increasing Trainer Literacy in Sustainable Agriculture (ENC95-06)
- Life After CRP (ENC95-05)
- Local Sustainable Agriculture Team Building: A Sustainable Agriculture Training Model (ENC95-04)
- Developing Educational Materials and Schools for Sustainable and Profitable Grazing Systems (ENC95-03a)

1994

- North Dakota/South Dakota Professional Development Project (ENC94-02)
- North Central Sustainable Agriculture Training Program (ENC94-01)



Northeast Region

1997

- A Comprehensive Training in Sustainable Agriculture (ENE97-36)
- Review and Evaluation of Educational and Reference Materials Pertaining to Nutrient Management and Soil Health for Sustainable Agriculture Production (ENE97-35)
- CSA—Building a Future for Farming in the Northeast (ENE97-34)
- Riparian Buffer Training (Enhancement, Installation, and Management of Riparian Buffer Systems) (ENE97-33)
- The Farmer's Relevant Voice: A Farmer-Produced Educational Program for Watershed Coordinators (ENE97-32)
- Multi-Media Aids and In-Service Training Program for Using Insecticidal Nematodes (ENE97-31)
- A Video of Innovations in On-Farm Marketing in New England (ENE97-30)
- University of Maine Cooperative Extension Compost School (ENE97-29)
- Developing and Publishing Sustainable Farming Resources for Agricultural Extension Professionals and Field Crop Producers (ENE97-28)

1996

- In-Service Training on Sustainable Animal Agriculture (ENE96-27)
- Management and Evaluation of Soil Health: Inservice Education for the Mid-Atlantic Region (ENE96-26)
- Cooperating for Sustainability and Adding Value: A Training Program on Cooperatives and Value Added Marketing for USDA Staff in the Northeast (ENE96-25)
- Training, Networking and Demonstrating Whole Farm Forage Grazing Systems (ENE96-24)
- Communication and Outreach for Sustainable Agriculture: A Video Training Program for Extension (ENE96-23)
- Video Training on Improving Water Quality Featuring Farmers and Their Practices in the German Branch Watershed (ENE96-22)
- Regionally Based Professional Development Program for Grazing Systems Management (ENE96-21)
- Holistic Resource Management: Eastern NY Pilot Project (ENE96-20)
- Development of Dairy Farm Management Groups in Vermont and New Hampshire (ENE96-18)
- Teaching to Achieve Sustainable Management of Phytophthora Diseases on Horticultural Crops (ENE96-17)
- A Diagnostic Team Approach to Enhancing Dairy Farm Sustainability (ENE96-16)
- Farmer-to-Farmer Learning Groups-Curriculum for Establishment and Facilitation (ENE96-15)

1995

- A Video Training on Cultivation Featuring Talented Farmers & Their Weed Control Machines (ENE95-9)
- New England Extension Sustainable Agriculture Training Program (ENE95-8)
- Information Management Training for Integrated Crop and Pest Management (ENE95-7)
- Addressing the Needs of Extension Faculty & Staff Through a New York State Cover Crop Symposium (ENE95-6)
- Promoting Sustainable Agriculture Through a Systems Approach to Consensus Building and Public Policy Education (ENE95-14)
- Whole-Farm/Whole-Watershed Planning for Sustainable Agriculture (ENE95-13)

Sustainable Agriculture in Northeast Communities: New Roles, New Skills for Agricultural Educators (ENE95-12)

- On-Farm Research & Extension Education Program (ENE95-11)
- Education of Extension Workers in Sustainable Agriculture Practices Utilizing the PASA Conference and Farm Visits (ENE95-10)

1994

- Developing a Northeast Pasture User Support Group Network to Sustain Agriculture (ENE94-5)
- Education of Pennsylvania Extension Workers in Sustainable Agriculture Practices (ENE94-4)
- Sustainable Agriculture In-Service Education: Managing Resources for the Future (ENE94-3)
- Extension Agent Training in Sustainable Agriculture (ENE94-2)
- New England Extension Sustainable Agriculture Training Program (ENE94-18)

Southern Region

1997

- Southern Region Sustainable Ag Training Consortium (ES97-14)
- Kentucky Cooperative Extension System Training Project (ES97-15)
- Developing Trained Professionals and Teaching Aids to Support Educational Programs Addressing Management of Stored Grain in the Southeast (ES97-16)
- The First Requirement of Agriculture Sustainability: Efficient Management of Available Resources (ES97-18)
- Nuisances in the Community: Training on the Issues and the Methods of Mediation (ES97-19)
- State Training in Integrated Erosion Control Systems (ES97-20)
- Building Capacity in Sustainable Agriculture: A Comprehensive Training Program in Organic Farming Systems for Cooperative Extension Agents, Specialists, and Other Educators (ES97-25)
- Community Food Security and Marketing Capacity Development (ES97-26)
- Community Food Security and Marketing Capacity Development in Kentucky (ES97-26)

■ Training Program for Agriculture Educators Targeting Integrated Cow/Calf Operation Management Systems (ES97-27A)
■ Grassroots Empowerment in Kentucky's Local Conservation Districts: Leadership Training on Sustainable Land and Water Quality Management Practices (ES97-28)
■ Implementing Tennessee's Strategic Plan for Sustainable Agriculture: Utilizing On-Farm Case Studies for Teaching Advanced Management and Marketing to Extension Staff (ES97-29)
■ Integrated Production of Sustainable Crops for Small Farmers in North Florida (ES97-30)
■ Development of Sustainability Checksheet, Manual and Workshops to Train Educators Planning Beef Programs (ES97-31)
■ Responding to Expressed Needs: SARE/ACE Regional Training with the Sustainable Dairy Systems Manual and Software (ES97-32)
■ Alternative Sustainable Practices for Selected Crops in Puerto Rico (ES97-33)
■ Multi-State Value Added Team Building in the Northern Mississippi River Delta Region (ES97-34)
■ Integrated Strategic Plan for Sustainable Agriculture (ES97-35)
■ Sustainable Agriculture Training Initiative for Texas (ES97-36)

1996

■ Sustainable Agriculture Marketing through Collaborative Policy Development (LST96-13)
■ Facilitating Farmer to Farmer Networks: An Experimental Approach (LST96-12)
■ Southern Gathering on Agricultural Problem Solving (LST96-11)
■ Sustainable Small-Scale Agricultural Development Training Project (LST96-10)
■ Management-Intensive Grazing: Foundation of Sustainable Agriculture in the South (LST96-09)
■ Southern Region Sustainable Agriculture Training Consortium (LST96-8/LST94-1)

1994

■ Evaluating Sustainability: Gaining Insights (LST94-7)
■ Extending Sustainable Agriculture Concepts and Practices to Traditional Agricultural Advisors (LST94-6)
■ Sustainable Cotton Production for the South (LST94-5)
■ Sustainable Dairy Systems Manual and Training (LST94-4)
■ Environmentally and Economically Sustainable Use of Rangeland (LST94-2)

Western Region

1997

■ Constructing a Herbarium, Collection and Key to Medicinal and Other Traditional Plants of Samoa (EW97-18)
■ Composting Education and Information Access for Western Agriculture (EW97-12)
■ Sustainable Youth Education: Professional Development for Youth Program Leaders and Educators (EW97-07)
■ In-Depth Training and Work Experience on a Community Supported Agriculture (C.S.A.) Farm (EW97-05)
■ Developing an Educational Program for Teaching Science-Based Concepts of Grass Regrowth for Improved Grazing Management (EW97-04)
■ Tools for Sustainability: Sustainable Agriculture Video Training Tapes for the Pacific Islands Region (EW97-03)
■ Sustainable Range & Pasture Livestock & Dairy Production Training for Resource Professionals (EW97-02)

^1996

■ Continuation — "Training Agents" in On-Farm Implementation of Sustainable Management Systems for Tropical Agriculture in Hawaii and the Pacific Region (EW96-14)
■ Professional Training in Biologically Integrated Orchard Systems (EW96-11)
■ Sustainable Arid Land Grazing Systems: Training for Managers of Public Lands and Reserves (EW96-10)
■ Sustainable Agriculture Curriculum Development Project for Extension Professionals in California's San Joaquin Valley and Central Coast Regions (EW96-09)
■ Organic Food Production and Marketing - Tours and Resource Guide (EW96-06)
■ Multidisciplinary On-Site Training in Sustainable Agriculture Education (EW96-05)
■ Extension Faculty Learning with Farmers—A Seminar Series on Sustainable Agriculture (EW96-04)
■ Improving Manure Management to Protect Water Quality in the Southwestern U. S. (EW96-02)

1995

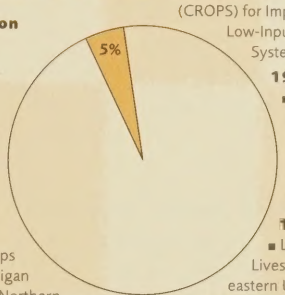
■ Video Introduction to Sustainable Agriculture in the Western U.S. (EW95-18)
■ A Consortium-Based Sustainable Agriculture Training Program (SATP) Curriculum (EW95-15)
■ Sustainable Agriculture Training Project A Model of Collaborative Learning (EW95-12)
■ Sustainable Integrated Range Livestock & Crop Production Systems (EW95-08)
■ Agency Personnel Training in Riparian Monitoring and Management of Wildlife and Livestock in the Intermountain West (EW95-03)
■ Sustainable Noxious Weed Management on Northwestern Rangelands (EW95-02)
■ Educational Video on Watershed Management Practices for Pinyon-Juniper Ecosystem (EW95-01)

1994

■ Extension Sustainable Agriculture Training in Colorado and Wyoming (EW94-18)
■ Training "Agents" in On-Farm Implementation of Sustainable Management Systems for Tropical Agriculture in Hawaii and the Pacific Region (EW94-14)
■ Permaculture Systems Pamphlet (EW94-09)
■ Pacific Northwest Sustainable Agriculture Systems Training Program (EW94-08)
■ Multidisciplinary On-Site Training in Sustainable Agriculture Education (EW94-03)

INTEGRATED FARM/RANCH SYSTEM

North Central Region



1997

■ Cluster Use of Whole-Farm Planning with Decision Cases and Evaluation (LNC97-106)
■ Diversifying a Small Crop Farm with Hogs and Poultry on Pasture, Apple Trees, and Plums (FNC97-190)
■ Developing Partnerships Between Southern Michigan Cash Crop Farmers and Northern Michigan Livestock Farmers (FNC97-168)

1996

■ Packaging, Testing, and Disseminating a Set of Indicators for Ecological, Financial, and Social Monitoring on Farms (LNC96-109)
■ Permaculture Greenhouse System: Integrating Greenhouse and Poultry Production (FNC96-139)

1995

■ Integrating Quality of Life, Economic, and Environmental Issues: Agroecosystem Analysis of Amish Farming (LNC95-91)

1994

■ Biological, Financial and Social Monitoring to Develop Highly Sustainable Farming Systems (LNC94-75)
■ Developing a Stewardship Plan for Water Quality (FNC94-86)

1993

■ On-Farm Adaptation of Integrated Crop and Livestock Systems in Illinois (LNC93-56)

1992

■ Development of Methods Toward Sustainable Apple and Poultry Production (ANC92-14)

1990

■ Economic, Ecological and Environmental Analyses of Farms Under Long-Term Lower Chemical Input Management (LNC90-26)

1988

■ Evaluation of Integrated Low-Input Crop-Livestock Production Systems (LNC88-13)

Northeast Region

1993

■ Small Farm Biogas Production & Use (FNE93-19)
■ Systems Analysis of Organic and Transitional Dairy Production (LNE93-39)

1992

■ A Living Laboratory/Classroom for the Integration of Research and Education Efforts on Alternative Vegetable Production Systems (LNE92-32)

1990

■ The Integration of Crop (Potato) and Livestock Production Systems (LNE90-23)

Southern Region

1997

■ Sustainable Crop/Livestock Systems in the Texas High Plains (LS97-82)

1996

■ Multi-Cropping Cattle and Watermelon in the Southern Plains (LS96-79)
■ Improving Integrated Resource Management Skills of Beef Producers (LS96-74)

1992

■ CROPS, The Crop Rotation Planning System, for Whole Farm Environmental and Economic Planning (AS92-04)

1991

■ Low-input Crop and Livestock Systems for the Southeastern United States (LS91-37)

1990

■ An Expert Crop Rotation Planning system (CROPS) for Implementing and Evaluating Low-Input Crop and Livestock Systems (LS90-29)

1989

■ Enhancement of the Stability of Southern Region Agroecosystems Through Profitable Transition to Sustainable Agriculture (LS89-15)

1988

■ Low-Input Crop and Livestock Systems for the Southeastern United States (LS88-8.2)
■ Development, Implementation and Evaluation of Low-Input Crop and Livestock Systems for the Southern Region (LS88-08)
■ Whole-Farm Low/Reduced Input Farming Systems and Educational Program (LS88-02)

Western Region

1997

■ Systems Thinking in a Range Environment (FW97-024)

1996

■ Legume Grazing in Rotation with Small Grains (FW96-008)

1995

■ Public-Land Grazing Permittees Under Pressure: Sustainability of Coping Strategies on Private Land (SW95-15)
■ Monitoring Program for Biologically Integrated Orchard Systems (BIOS) in Walnuts (FW95-089)
■ Demonstration and Implementation of Integrated Fruit Production on Anjou Pears (FW95-072)
■ Initiation of Integrated Management (FW95-067)
■ Intensive Grazing in Asian Pear Orchards (FW95-057)

1994

■ Legume Cover Crops in Fallow as an Integrated Crop/Livestock Alternative in the Northern and Central Great Plains (SW94-06)

1993

■ Four-Corners Navajo Nation Sustainable Agriculture Demonstration Project (LW93-34)
■ Development of Sustainable Crop and Livestock Production Systems for Land in the Conservation Reserve Program (CRP) (LW93-33)

1992

■ Grazing Strategies for Sustainable Ranching Systems in Western Semi-Arid Zones (LW92-31)
■ Integrated Hog Farming and Market Gardening for Small Farmers in Tropical Areas of the Western Region (LW92-2)
■ Comparative Performance and Farm-Level Function Conventional and Certified Organic Apple Production Systems in California (AW92-09)

1991

■ Development of Sustainable Potato Production Systems for the Pacific Northwest (LW91-29)
■ Specifying and Analyzing Whole-Ranch Systems for Sustainable Range Livestock Production in Environmentally Sensitive Areas (LW91-24)
■ Biological Management of Understory Vegetation in Macadamia Orchards: A Whole-Farm Systems Approach (AW91-04)

1989

■ A Comparison of Conventional, Low-Input and Organic Farming Systems: The Transition Phase and Long-Term Viability (LW89-18)
■ Silvopastoral Alternatives for Fruit Growers (LW89-17)

1988

■ Comparative Study of Established Organic and Conventional Tomato Production Systems in California (LW88-03)
■ Options to Enhance the Sustainability of Dryland Cereal Cropping in the Northwest (LW88-02)

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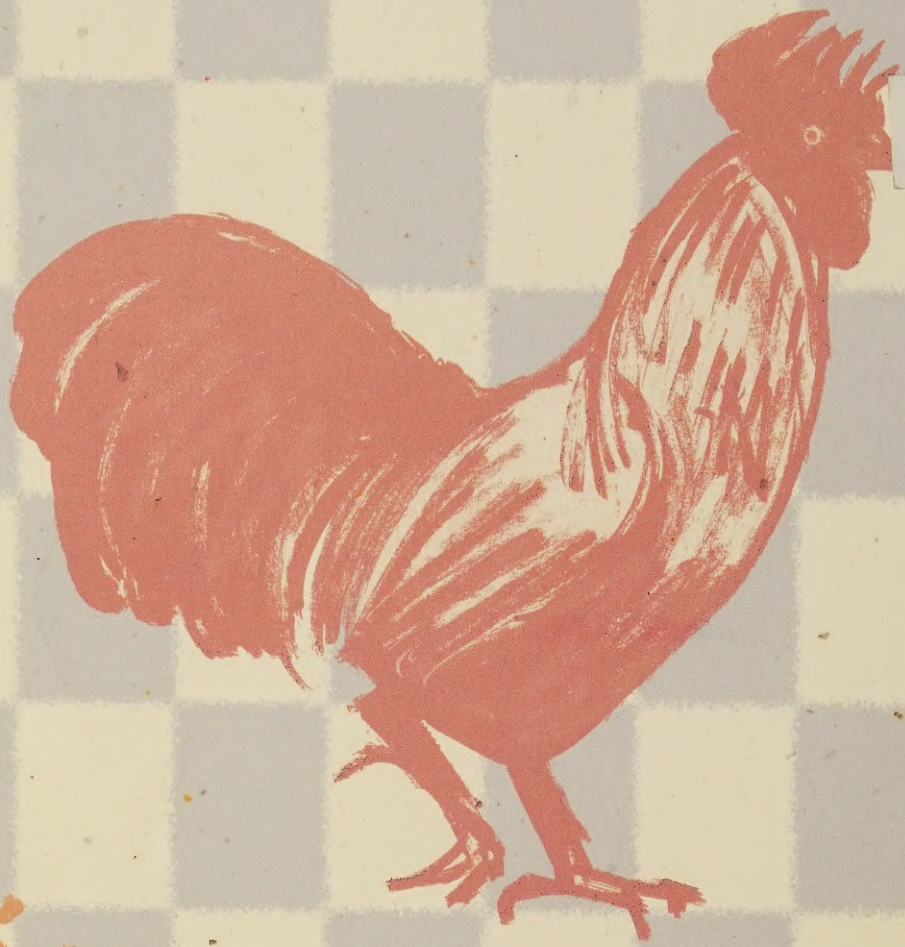

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